DOCUMENT RESUME

ED 315 302 SE 051 183

AUTHOR	Pfeiffenberger, G. Will; Zolandz, Ann Marie
TITLE	Surveys of the Use of Hand Calculators in College Preparatory and College Science Classes.
INSTITUTION	College Entrance Examination Board, New York, N.Y.
REPORT NO	CBR-89-4; ETS-RR-89-2
PUB DATE	89
NOTE	124p.
AVAILABLE FROM	College Board Publications, Box 886, New York, NY 10101 ($7.00).
PUB TYPE	Reports - Research/Technical (143) -- Tests/Evaluation Instruments (160)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Calculators; College Mathematics; College Science; Higher Education; *Mathematics Education; *Microcomputers; *Science Education; Secondary Education; Secondary School Mathematics; Secondary School Science; *Standardized Tests; Surveys

ABSTRACT

The availability of relatively inexpensive hand calculators and microcomputers is believed to be having an important effect on the teaching of mathematics and science in the United States. The appropriateness of allowing the use of this technology on standardized tests has become a concern of educators and organizations involved in testing. Informed decisions about calculator and microcomputer use policies should be made with consideration of standard classroom practices and the opinions of teachers at the secondary and postsecondary levels. To help determine this information, surveys of secondary and postsecondary schools across the United States were conducted. This document summarizes this process, and discusses the results of the surveys. Most secondary and postsecondary physics and chemistry instructors allowed the use of nonprogrammable calculators for course work and some tests, and expressed approval for certain standardized tests. Biology instructors were less approving of the use of calculators on tests. Included in the appendices are contact letters, copies of the surveys, lists of academic topics involved, and summaries of comments and responses to the surveys. (CW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

"PERMISSION TO REPRODUCE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Robert Cameron

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

College Board Report

No. 89-4

Surveys of the Use of Hand Calculators and Microcomputers in College Preparatory and College Science Classes

G. Will Pfeiffenberger
Ann Marie Zolandz

Surveys of the Use of Hand Calculators and Microcomputers in College Preparatory and College Science Classes

G. Will Pfeiffenberger
Ann Marie Zolandz

College Board Report No. 89-4
ETS RR No. 89-2

College Entrance Examination Board, New York, 1989

G. Will Pfeiffenberger is a senior examiner at Educational Testing Service, Princeton, New Jersey.
Ann Marie Zolandz is an associate examiner at Educational Testing Service, Princeton, New Jersey.

Acknowledgments

These surveys were conducted with the concurrence of the College Board Sciences Advisory Committee. The authors wish to express their appreciation to the following persons who made valuable contributions to the surveys: Walter MacDonald, Naomi Martin, Diane Pege, Hessy Taft, Beverly Whittington, and Gita Wilder, who reviewed drafts of the questionnaires; Mary Kern and Dorothy Morrell, who coordinated the mailings of the questionnaires and the recording of the returns of the completed questionnaires; Connie Pilla and the staff of ETS Key Entry Services who entered the data and downloaded it to disks; Chancey O. Jones and Beverly Whittington, who reviewed the drafts of the report and made helpful suggestions; and the secondary school, college, and university science chairpersons and faculty who participated in this study.

Researchers are encouraged to express freely their professional judgment. Therefore, points of view or opinions stated in College Board Reports do not necessarily represent official College Board position or policy.

The College Board is a nonprofit membership organization committed to maintaining academic standards and broadening access to higher education. Its more than 2,600 members include colleges and universities, secondary schools, university and school systems, and education associations and agencies. Representatives of the members elect the Board of Trustees and serve on committees and councils that advise the College Board on the guidance and placement, testing and assessment, and financial aid services it provides to students and educational institutions.

Additional copies of this report may be obtained from College Board Publications, Box 886, New York, New York 10101. The price is $7.

Copyright © 1989 by College Entrance Examination Board. All rights reserved.
College Board, Advanced Placement Program, Scholastic Aptitude Test, SAT, and the acorn logo are registered trademarks of the College Entrance Examination Board.
Printed in the United States of America.

CONTENTS

Background 1

Secondary School Survey
- Procedure 1
- Results 1

College and University Survey
- Procedure 6
- Results 6

Summary and Conclusions 10

Tables

1. Number of Secondary Schools Receiving and Returning Questionnaires 2

2. Number of Postsecondary Schools Receiving and Returning Questionnaires 7

Appendix 1. Secondary School Survey

1a. Cover Letter 12
1b. Hand Calculator and Microcomputer Surveys
- Physics 13
- Chemistry 19
- Biology 25
- Miscellaneous 31

1c. Follow-Up Postcard 36
1d. Responses for Part A: Hand Calculators 37
1e. Topics Involving Calculator Use and Related Texts 44
1f. Comments Regarding Changes in Classroom Practices in Response to Calculator Use on Standardized Tests 50
1g. Concerns Regarding Calculator Use on Standardized Tests 53
1h. Responses for Part B: Microcomputers 55
1i. Topics Involving Microcomputer Use 58
1j. Available Computer Models 62
1k. Skills Assessed via Computers and Related Comments 63

Appendix 2. College and University Survey

2a. Cover Letters 65
2b. Hand Calculator and Microcomputer Surveys
- Physics 68
- Chemistry 74
- Biology 80

2c. Follow-Up Postcard 86
2d. Responses for Part A: Hand Calculators 87
2e. Topics Involving Calculator Use and Related Texts 92
2f. Comments Regarding Students' Calculator Use 99
2g. Concerns Regarding Calculator Use on Standardized Tests 102
2h. Responses for Part B: Microcomputers 105
2i. Topics Involving Microcomputer Use 111
2j. Available Computer Models 115
2k. Skills Assessed via Computers and Related Comments 118

BACKGROUND

The availability of relatively inexpensive hand calculators and microcomputers is believed to be having an important effect on the teaching of mathematics and science. Therefore, the appropriateness of allowing the use of hand calculators on standardized tests has become a concern of both educators and organizations involved in testing, such as the College Board and ETS. Also of interest is the potential for tests that could be delivered using microcomputers. Although many groups have enthusiastically advocated curricular change associated with the new technologies, it is not clear whether these changes actually have been implemented widely at the classroom level.

Informed decisions about calculator use policies for standardized tests and about the possible incorporation of microcomputers into these tests should be made with consideration of standard classroom practices and the opinions of teachers at the secondary and postsecondary levels. To help determine this information, the College Board's Science Advisory Committee and Mathematical Sciences Advisory Committee recommended that surveys of secondary school and postsecondary faculty be conducted in these areas.

For the secondary school survey, four questionnaires relating to the use of hand calculators and computers were developed: one each for physics, chemistry, and biology, and one for any other science courses (referred to here as the miscellaneous questionnaire). A copy of each was circulated to science department chairpersons in each of 420 secondary schools throughout the United States. (See Appendixes 1a and 1b.)

For the postsecondary school survey, three questionnaires relating to the use of hand calculators and computers were developed: one each for physics, chemistry, and biology. (See Appendixes 2a and 2b.) Two copies of the appropriate questionnaire were circulated to department chairmen for each subject in each of 391 colleges and universities in the United States and Puerto Rico, and 1 in Canada.

SECONDARY SCHOOL SURVEY

Procedure

The stratified sample was chosen at random by College Board computer staff from their list of all secondary schools in the United States that have a school code to be used by students when registering for College Board examinations. The five groups in the sample were divided as follows: the upper 50 percent of College Board Achievement Test[1] users by volume (150), the lower 50 percent of Achievement Test users by volume (150), nonusers by large institution size (40), nonusers by medium institution size (40), and nonusers by small institution size (40). (See Table 1.) The questionnaires were mailed to schools in November 1986 with a requested return date of mid-December 1986. A follow-up postcard (see Appendix 1c) extended the deadline to January 31, 1987.

A total of 579 questionnaires were returned from 178 schools: 155 questionnaires for physics, 154 for chemistry, 151 for biology, and 119 for miscellaneous courses. There was a 55 percent return from the upper half of Achievement Test users, a 41 percent return from the lower half of Achievement Test users, a 30 percent return from nonusers classified by large institution size, a 30 percent return from nonusers by medium institution size, a 25 percent return from nonusers by small institution size, and a 42 percent return overall. The returns from the two groups of Achievement Test users appear to represent the sample in terms of distribution among geographic regions and private and public schools. The sample of the nonusers contained predominantly public schools from the mid-west and south-central regions of the United States, and the returns are representative of the samples.

The responses to questions 1–4, 6–14, and 17–21 (some question numbers differ in the miscellaneous questionnaire) were keyed in by ETS personnel in Key Entry Services, downloaded to a microcomputer, and analyzed using Lotus 1-2-3. The comments that appeared on the returned questionnaires were read individually.

Results

I. Hand Calculators (Part A of Questionnaire)

For the purpose of this survey, calculators are divided into three types: I. Simple: Arithmetic functions only. Usually costs less than $10. II. Scientific: Includes trigonometric and exponential functions. Usually costs between $10 and $20. III. Programmable: Usually costs more than $20.

The tabulated results from the questionnaires that were returned can be found in Appendix 1d. The numbers on pages 38 through 41 represent the number of individuals that checked each box. The numbers do not add up to the total number of questionnaires received because in some cases, individuals did not respond to all questions or did not respond for a particular calculator type. There were also a few cases in which the responses

1. The College Board Achievement Tests are intended to provide useful information for college admissions and, to a lesser extent, are used by the colleges for placement.

Table 1. Number of Secondary Schools Receiving and Returning Questionnaires

	Achievement Test Users				*Nonusers*							
	Upper 50%		*Lower 50%*		*Large*		*Medium*		*Small*		*Totals*	
State	*Rec'd*	*Ret'd*	*Rec'd*	*Ret'd*	*Rec'd*	*Ret'd*	*Rec'd*	*Ret'd*	*Rec'd*	*Ret'd*	*Rec'd*	*Ret'd*
Alabama	—	—	3	2	3	1	3	0	2	0	11	3
Alaska	1	1	—	—	—	—	—	—	—	—	1	1
Arizona	—	—	4	2	1	*	1	0	—	—	6	2
Arkansas	—	—	—	—	—	—	1	0	2	0	3	0
California	12	4	12	4	2	0*	—	—	—	—	26	8
Colorado	1	1	2	2	—	—	—	—	1	0	4	3
Connecticut	4	2	2	1	—	—	—	—	—	—	6	3
Delaware	1	1	—	—	—	—	—	—	—	—	1	1
Florida	7	5	5	2	—	—	—	—	—	—	12	7
Georgia	5	2	3	1	—	—	—	—	—	—	8	3
Hawaii	1	0	—	—	—	—	—	—	—	—	1	0
Idaho	—	—	—	—	—	—	—	—	1	0	1	0
Illinois	3	2	3	3	7	3	3	3	3	0	19	11
Indiana	5	2	8	5	—	—	—	—	—	—	13	7
Iowa	—	—	1	1	1	1	3	0	5	2	10	4
Kansas	—	—	4	3	—	—	1	1	3	2	8	6
Kentucky	—	—	—	—	3	1	2	0	—	—	5	1
Louisiana	—	—	—	—	4	1	2	1	1	0	7	2
Maine	1	0	1	1	—	—	—	—	—	—	2	1
Maryland	6	1	2	1	—	—	—	—	—	—	8	2
Massachusetts	10	5	2	1	—	—	—	—	—	—	12	6
Michigan	1	1	8	3	4	2	5	2	2	1	20	9
Minnesota	2	2	2	2	1	*	2	0	2	2	9	6
Mississippi	—	—	—	—	2	0	3	2	2	0	7	2
Missouri	—	—	1	1	1	0	2	1	2	0	6	2
Montana	—	—	—	—	—	—	—	—	1	0	1	0
Nebraska	—	—	—	—	2	0	—	—	3	1	5	1
Nevada	—	—	—	—	—	—	—	—	—	—	—	—
New Hampshire	1	1	2	1	—	—	—	—	—	—	3	2
New Jersey	12	6	2	1	—	—	—	—	—	—	14	7
New Mexico	—	—	1	1	—	—	1	0	1	0	3	1
New York	22	13	19	5	1	1	—	—	—	—	42	18
North Carolina	9	5	7	2	—	—	—	—	—	—	16	7
North Dakota	—	—	—	—	—	—	—	—	1	0	1	0
Ohio	2	1	8	3	3	0	4	0	1	0	18	4
Oklahoma	—	—	—	—	1	1	2	2	2	0	5	3
Oregon	3	2	1	0	—	—	—	—	—	—	4	2
Pennsylvania	17	10	8	4	—	—	—	—	—	—	25	14
Rhode Island	3	1	—	—	—	—	—	—	—	—	3	1
South Carolina	3	2	6	1	—	—	1	0	—	—	10	3
South Dakota	—	—	—	—	—	—	—	—	2	1	2	1
Tennessee	—	—	2	0	2	0	3	0	—	—	7	0
Texas	7	4	17	5	1	1	—	—	2	1	27	11
Utah	—	—	2	0	1	0	—	—	—	—	3	0
Vermont	1	1	3	1	—	—	—	—	—	—	4	2
Virginia	9	7	1	1	—	—	—	—	—	—	10	8
Washington	—	—	3	0	—	—	—	—	—	—	3	0
West Virginia	—	—	2	0	—	—	—	—	—	—	2	0
Wisconsin	—	—	2	1	—	—	—	—	1	0	3	1
Wyoming	—	—	—	—	—	—	—	—	—	—	—	—
Dist. Columbia	1	1	1	1	—	—	1	0	—	—	3	2
Totals	150	83	150	62	40	12	40	12	40	10	420	178
Percentage		55%		41%		30%		30%		25%		42%

*One survey returned undelivered.

to the last three rows of question 1 were inconsistent (i.e., more than one response per calculator type). For regular physics, chemistry, and biology courses, if the totals for the last three rows are adjusted by accounting for inconsistencies and those who did not respond for each calculator type, the numbers obtained are approximately the total number of surveys returned. This was also true for questions 2, 3, and 4. For Advanced Placement (AP) courses, the largest total thus obtained was taken to be the total number of responses for such courses, yielding totals of 37 for physics, 62 for chemistry, and 70 for biology. The 119 miscellaneous questionnaires represented 161 courses. A discussion of the responses to each question follows.

In the physics questionnaire, Advanced Placement teachers were asked to indicate which course they were teaching; 17 checked Physics B, 8 indicated Physics C, and 12 checked neither. Similarly, those completing the miscellaneous questionnaire were asked to indicate the type of course; 17 checked General Science, 54 checked Physical Science, 51 checked Earth Science, 30 checked Other, and 9 gave no response. The types of courses in the "Other" category that were indicated are listed in Appendix 1d.

Question 1. This question asked teachers to indicate the uses of calculators in their courses.

Most of the physics teachers who responded for each type of calculator permitted their use for all types of course work and tests. None indicated a decision to prohibit the use of type I calculators, but 39 percent of those returning questionnaires left this column blank for the regular course. Also, 34 percent left the column for type III blank. Of those responding for an AP course, 43 and 27 percent left the type I and type III columns blank, respectively.

The result for chemistry was similar to that of physics. Most of the chemistry teachers who responded for each type of calculator permitted their use for all course work and tests. In regular courses, nearly half of those who returned questionnaires did not respond for type III. About 35 percent of the AP teachers did not respond for type I, and about 37 percent did not respond for type III. The high nonresponse rates for calculator types I and III for chemistry and physics are probably because of the finding that these types of calculators are not commonly owned or used by students in these classes (see questions 3 and 4 below).

In regular biology courses, about 30 percent of those who returned questionnaires left the type II column blank and 53 percent left the type III column blank. The percentage of teachers allowing type I for various kinds of course work ranged from 60 to 67, and represented the greatest positive responses. Only 30 percent indicated type I calculator use for all tests, and 26 percent allowed it on some tests. Of all those teaching AP courses, 23 percent did not respond for type I, 10 percent did not respond for type II, and 44 percent did not respond for type III. The percentage of teachers allowing calculators for course work was in the 50s for type I and the high 60s for type II. The highest acceptance for test use was that for type II: 46 percent permitted their use on all tests, and 20 percent on some tests. The corresponding percentages for type I were 31 and 20 percent, respectively.

In the miscellaneous courses, only type III calculators received a low response, with only 37 percent of 161 courses containing a response for that column. Most teachers allowed type I calculators for course work, and the percentages for type II were in the 40s. Type I received the highest response for all tests; 43 percent of the teachers indicated they allowed their use.

To summarize, calculator types I and II are generally accepted in physics and chemistry courses. More teachers disallow calculators on tests in biology and other courses than in physics and chemistry. It seems calculator type III is not as accepted as types I or II.

Question 2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?

Most physics teachers (nearly 90 percent for both regular and AP Physics courses) responded for type II calculators, while the response for types I and III ranged from 42 to 54 percent. For both course types, of those responding for type II, about 70 percent provided teaching or assistance; responses for types I and III ranged from 32 to 42 percent.

About 85 percent of the chemistry teachers for each course responded for type II, and about 30 percent for each course responded for type III. For type I, 72 percent of the regular course teachers responded, while only 46 percent of AP teachers did so. In the regular courses, there was a somewhat greater tendency to provide teaching or assistance with types I and II than in the AP courses, and a slightly lesser tendency to provide assistance with type III.

In biology, most teachers responded for type I calculators for regular courses (83 percent), and fewer than half responded for the other two types. For AP courses, the response rate was less diverse (60, 66, and 46 percent for I, II, and III, respectively). Very few of those responding provided any kind of teaching or assistance (20 percent or fewer in any category).

For the miscellaneous courses, the response for various calculator types was similar to the regular biology courses. Some of the teachers responding provided teaching or assistance with types I and II (27 and 34 percent), but relatively few did so for type III.

Question 3. About what percentage of your students own each type of calculator?

Most of the physics students owned type II calculators. The same was true of the chemistry students, although more owned type I than did those in physics. For biology, the number who owned types I or II was about equal, and in the miscellaneous courses, more students owned type I than type II. In all cases, relatively few owned type III calculators.

Question 4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?

For physics and chemistry, the results are about the same as in question 3: most of those who owned calculators were using them. In biology, the number of students who used calculators was less than the number who owned them. This was probably due to two factors: slightly more biology teachers than physics or chemistry teachers prohibited calculators, and there are fewer opportunities to use calculators in biology than in the other two sciences. The miscellaneous courses show slightly less use than ownership, but the difference was not large.

Question 5. Please list below any topics you teach that make use of the calculator. (In the physics questionnaire, this question read, "If you teach special techniques that make use of the calculator, please list these techniques below.")

For physics, only about 18 percent of the teachers responded with specific topics; a few indicated "all math" or "problem solving." The other questionnaires received a much better response: chemistry, 85 percent; biology, 72 percent; and miscellaneous, 75 percent. This discrepancy in response rates may be due to the difference in the phrasing of the question, which was an oversight by the authors while drafting the questionnaires.

The following request was made in conjunction with question 5: "Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above." The response rates for this were as follows: physics, 12 percent; chemistry, 35 percent; biology, 25 percent, and miscellaneous, 28 percent.

Appendix 1e. lists by questionnaire the topics and texts mentioned by the respondents.

Question 6. If calculators are permitted in your classes, are they provided by the school district?

Very few school districts provide calculators. The percentage of teachers responding Yes were as follows: physics, 9 percent; chemistry, 8 percent; biology, 3 percent; and miscellaneous, 8 percent. In addition, a few teachers indicated that they were provided with a few calculators to use as "loaners" when students forgot to bring their own.

Question 7. Do you think students should be permitted to use calculators on the following tests?

The miscellaneous questionnaire inquired only about the Scholastic Aptitude Test (SAT)-mathematical sections. The others also inquired about the Achievement Tests and AP Examination in their respective subjects.

For the SAT, those who did not respond ranged from about 25 to 35 percent for type I calculators, 15 to 30 percent for type II, and 30 to 50 percent for type III. For those who did respond, the result was the same for all four questionnaires—close to half the respondents were in favor of allowing types I and II calculators, and nearly half were not in favor of their use. Most teachers did not favor use of type III calculators, with a ratio of 3 to 1 against their use for the miscellaneous questionnaire, and about 4 to 1 against their use for the other three questionnaires.

Again, about 40 percent of the teachers did not respond for type I for the physics tests. They strongly favored allowing use of types I and II by margins of about 8 to 1 and 12 to 1, respectively, for the Achievement Tests, and 7 to 1 and 11 to 1, respectively, for the AP Examinations. Approximately equal numbers were for and against type III.

In chemistry, the respondents also expressed strong acceptance of types I and II on the subject tests; the ratios for the Achievement Tests were 17 to 1 and 13 to 1, while those for the AP Examinations were 22 to 1 and 18 to 1. They disapproved of type III by a ratio of 2 to 1.

The biology teachers favored allowing types I and II on the subject tests, but only by a margin of about 2 to 1 for both tests. They also disapproved of type III by about 2 to 1.

To summarize, the teachers favored allowing calculator types I and II on the subject tests. The responses for type III were either nearly evenly divided or disapproving. The responses for types I and II on the SAT were nearly evenly divided, but the teachers clearly disapproved of using type III.

Questions 8–10. If calculator use were permitted on any of the tests listed in Question 7, would you change your calculator policy for any of your courses/the content of your courses/your method of teaching in any of your courses? (These questions did not appear on the miscellaneous questionnaire.)

Very few teachers in any subject indicated that they would make changes in their courses in response to changes in testing policies. The largest number respond-

ing Yes to a question was 12 in biology, representing 8 percent of the respondents. Some of those answering No indicated that there would be no need for a change since they already permitted the use of calculators in their classes. Appendix 1f. lists the comments made by those who answered Yes to any of these questions.

Question 11(8)[2]. Do you have any concern about the use of calculators on standardized tests in general?

For chemistry, approximately 30 percent of the teachers responded Yes to this question, while about 35 percent responded Yes in the other three questionnaires. The main concerns were: students who bring information to the test in programmable memories, the equity issue (both availability and uniformity), dependence on calculator use, and the nonmastery or deterioration of skills. Some also indicated they thought calculators should be allowed on science tests (sometimes with the qualification that the concerns mentioned above be remedied), but should not be allowed on mathematics tests, which attempt to assess the skills that calculator use would replace. A summary of concerns is given in Appendix 1g.

II. Microcomputers (Part B of Questionnaire)

The tabulated results for much of this part of the survey can be found in Appendix 1h.

Question 12(9). For each course, check boxes to indicate how microcomputers are used in your classes.

For each distinct use of a computer, the response to this question was somewhat low, with 39 percent the largest percentage of teachers who checked any one box. However, the percentages of teachers reporting any use of a computer were larger, ranging from 47 percent in Regular Biology and miscellaneous courses to 66 percent in Regular Physics courses. In general, fewer classes employed computers for interfacing, programming, and communication with outside networks than they did for the other uses listed. Also, the use in biology courses was, overall, less than that in the other kinds of courses. The programming languages indicated are listed in the table below question 12.

Question 13(10). If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?

The greatest percentage of teachers responding Yes occurred for AP Chemistry courses (30 percent), while the smallest number was for Regular Biology courses (19 percent). In all cases, these figures tend to be lower than the greatest response to the previous question by 10 percent or less, implying that most of the teachers who use computers provide some type of teaching or assistance in their use. The average number of hours spent on this activity ranged from about 4 to 10 per year.

Question 14(11). Has the course been modified to include topics that are particularly suited to the use of the computer?

For the most part, few teachers have made modifications to accommodate the use of computers. All the positive responses were below 12 percent except for AP Biology, which was 27 percent.

Question 15(12). Please indicate the topics in each course that are particularly suited to the use of the computer.

The response to this question ranged from about 30 to 35 percent. The tendency to simply indicate "all math work" seemed most prevalent in chemistry. Appendix 1i lists the topics indicated for each questionnaire.

Question 16(13). What computer makes and models are available at your school for student use?

Often, teachers responded to this question even if they didn't make use of computers themselves. The approximate rates of response were: physics, 50 percent; chemistry, 80 percent; biology, 60 percent; and miscellaneous, 60 percent. An overwhelming majority of schools provided one or more models of the Apple computer for their students. A number of other makes were represented, but in far fewer numbers. The models indicated for each questionnaire are listed in Appendix 1j.

Question 17(14). About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

A majority of those responding to this question did not replace any labs with simulations. For any kind of course, at most only one teacher responded in the 26 to 50 percent range, and only one teacher indicated a higher percentage range.

Question 18(15). Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

About 12 percent of the teachers of miscellaneous courses responded Yes, while about 20 percent did so for the other subjects. Many teachers did not answer

2. Numbers in parentheses for questions 11–18 refer to the numbering of questions as they appear in the miscellaneous questionnaire, which differs because some questions were not asked in the miscellaneous questionnaire that were asked in the other three.

this question as intended, responding with topics instead of skills or responding from a teaching rather than an assessing point of view. Appendix 1k lists the skills, topics, and other comments indicated in each of the questionnaires.

Question 19. For each of the following tests, would you favor that computer-administered simulations designed to assess laboratory skills be given in conjunction with the normal test? (This question did not appear on the miscellaneous questionnaire.)

Each of the three subject-specific questionnaires inquired about the Achievement Tests and the AP Examinations for that subject. About 30 percent indicated they had no opinion in each case. Those expressing an opinion on the AP Physics Examinations were equally divided, while in all other cases the responses tended toward not using computers.

After this question (and question 15 for the miscellaneous questionnaire) the teachers were invited to attach any examples of calculator or microcomputer materials that they use, but only a few were received.

COLLEGE AND UNIVERSITY SURVEY

Procedure

The sample was chosen by College Board computer staff from their list of all postsecondary institutions in the United States, Puerto Rico, and Canada that have a college code to be used by students when registering for College Board Examinations. There were two groups in the sample—institutions requiring Achievement Test scores for admission (150), and a random selection of extensive users of Achievement Tests, defined as institutions that received 24 or more Achievement Test scores (242). (See Table 2.) The questionnaires were mailed to the 392 institutions in March with a return date of April 30. A follow-up postcard (see Appendix 2c) was sent in late April extending the deadline to May 15.

A total of 792 questionnaires were returned from a total of 315 institutions; 281 for physics, 317 for chemistry, and 194 for biology. There was no miscellaneous questionnaire for the college sample. The percentage of colleges that returned one or more questionnaires from those that require Achievement Test scores were 53 percent for physics, 52 percent for chemistry, and 31 percent for biology; the returns from the extensive users were 46 percent for physics, 57 percent for chemistry, and 40 percent for biology. The returns also appear to represent the sample in terms of distribution among geographical regions, private and public institutions, and colleges and universities.

The responses to questions 1–10 and 13–19 were keyed in by personnel in Key Entry Services and then downloaded to a microcomputer and analyzed using Lotus 1-2-3. The comments were read individually.

Results

I. Hand Calculators (Part A of Questionnaire)

The tabulated results from the questionnaires that were returned can be found in Appendix 2d. The numbers in the boxes on pages 88 through 90 represent the number of individuals that checked each box. The numbers do not add up to the totals because in some cases individuals did not respond to all questions or did not respond for a particular calculator type. There were also a few cases in which the responses to the last three rows of question 1 were inconsistent (i.e., more than one response per calculator type). If the totals for the last three rows are adjusted by accounting for inconsistencies and those who did not respond for each calculator type, the numbers obtained are approximately the total number of surveys returned. This is also true for questions 2 and 3. Also indicated at the top of pages 88 to 90 are the number of instructors in each group who responded for each kind of course. (The term "group" will be used here to mean either of the two sample groups mentioned above and, where appropriate, further breakdown by the kind of course for which a response was given. Since there are three subjects, two college samples, and two course types, there are as many as 12 groups per question.)

Question 1. This question asked instructors to indicate the uses of calculators in courses presently being taught.

The responses for the two types of physics courses (nonmajors course and majors course) were generally the same. A majority of physics teachers indicated that type II calculators are necessary for course work and permitted for all tests. Only a few indicated that they did not permit type I or III calculators, but between 40 and 60 percent of the respondents in each group left these columns completely blank.

About 65 percent of the chemistry instructors who were teaching a nonmajors course indicated that type II calculators were necessary for course work, about 80 percent of those teaching a course for majors indicated likewise, and approximately a third of each group indicated a necessity for type I. Between 40 and 60 percent of each group permitted calculator types I and III on tests (40 to 55 percent did not respond for these types), and nearly all allowed type II.

The high nonresponse rates for calculator types I and III for physics and chemistry is probably because

Table 2. Number of Postsecondary Schools Receiving and Returning Questionnaires*

State	*Users Requiring Achievement Test*				*Large Achievement Test Users*				*Totals*			
	Rec'd	*Phys. Ret'd*	*Chem. Ret'd*	*Bio. Ret'd*	*Rec'd*	*Phys. Ret'd*	*Chem. Ret'd*	*Bio. Ret'd*	*Rec'd*	*Phys. Ret'd*	*Chem. Ret'd*	*Bio. Ret'd*
Alabama	—	—	—	—	2	1	2	1	2	1	2	1
Arizona	—	—	—	—	2	1	2	1	2	1	2	1
California	13	5	6	6	20	6	6	7	33	11	12	13
Colorado	—	—	—	—	5	3	5	1	5	3	5	1
Connecticut	5	2	2	1	4	1	3	1	9	3	5	2
Delaware	—	—	—	—	1	0	1	0	1	0	1	0
Florida	1	0	1	0	5	1	3	2	6	1	4	2
Georgia	1	0	1	1	5	1	4	2	6	1	5	3
Hawaii	—	—	—	—	2	1	1	1	2	1	1	1
Idaho	—	—	—	—	1	1	1	1	1	1	1	1
Illinois	2	1	0	1	12	5	7	8	14	6	7	9
Indiana	2	2	1	1	6	3	5	4	8	5	6	5
Iowa	—	—	—	--	3	3	3	2	3	3	3	2
Kentucky	—	—	—	—	2	0	2	1	2	0	2	1
Louisiana	1	0	0	0	1	1	1	1	2	1	1	1
Maine	2	1	2	1	5	4	3	2	7	5	5	3
Maryland	2	1	1	0	4	2	0	2	6	3	1	2
Massachusetts	21	13	10	5	17	4	5	5	38	17	15	10
Michigan	1	1	1	0	9	6	4	6	10	7	5	6
Minnesota	—	—	—	—	2	2	2	1	2	2	2	1
Mississippi	1	1	0	0	—	—	—	—	1	1	0	0
Missouri	—	—	—	—	3	1	3	1	3	1	3	1
Montana	—	—	—	—	1	1	1	1	1	1	1	1
Nevada	—	—	—	—	1	0	0	0	1	0	0	0
New Hampshire	2	2	1	0	3	2	1	1	5	4	2	1
New Jersey	7	2	4	4	6	4	2	1	13	6	6	5
New Mexico	—	—	—	—	1	1	1	0	1	1	1	0
New York	19	9	12	5	28	14	13	13	47	23	25	18
North Carolina	4	3	2	3	5	3	5	2	9	6	7	5
Ohio	2	1	2	1	13	9	9	5	15	10	11	6
Oklahoma	—	—	—	—	2	1	1	2	2	1	1	2
Oregon	4	4	2	1	3	2	2	1	7	6	4	2
Pennsylvania	17	8	8	6	16	6	8	6	33	14	16	12
Rhode Island	1	1	1	1	3	1	1	1	4	2	2	2
South Carolina	2	1	2	0	1	1	1	0	3	2	3	0
Tennessee	1	1	1	0	2	1	2	0	3	2	3	0
Texas	6	3	2	2	13	7	10	4	19	10	12	6
Utah	1	0	0	0	2	1	1	1	3	1	1	1
Vermont	1	0	1	1	3	1	2	0	4	1	3	1
Virginia	7	5	3	2	13	5	5	4	20	10	8	6
Washington	—	—	—	—	5	3	3	1	5	3	3	1
West Virginia	—	—	—	—	3	0	1	1	3	0	1	1
Wisconsin	1	1	1	0	5	3	4	3	6	4	5	3
Dist. Columbia	4	2	3	1	2	1	2	0	6	3	5	1
Puerto Rico	18	8	7	4	—	—	—	—	18	8	7	4
Canada	1	1	1	0	—	—	—	—	1	1	1	0
Totals	150	79	78	47	242	111	138	97	392	193	216	144
Percentage		53%	52%	31%		46%	57%	40%		49%	55%	37%

*No questionnaires were sent to the states of Alaska, Arkansas, Kansas, Nebraska, North Dakota, South Dakota, or Wyoming.

these types of calculators are not commonly used by students in these classes (see question 3 below).

In biology courses, generally few did not respond for types I and II, and about a third or less did not respond for type III. The range of those who indicated no need for calculators in course work was about 40 to 70 percent. In the courses for nonmajors, 30 percent or less of each group thought they were necessary, while slightly more indicated a need for type I or II for laboratory work in courses for majors. In all groups there was a slight preference for allowing calculator types I and II on all tests rather than type III, but the differences were only about 10 percent. The percentage of instructors in biology who did not allow calculators on any tests was greater than for the other subjects: these instructors did not favor one type of calculator over another, but there were about twice as many from schools who require Achievement Tests as from the extensive users.

To summarize, calculator types I and II are generally accepted in these science courses; type II is preferred in physics and chemistry, and calculators in biology are not as useful. The advanced capabilities of the type III calculators are not generally needed, so they are not as useful as are types I or II, nor are they as likely to be permitted on tests.

Question 2. Is any class time devoted to teaching or assisting students in the use of the calculator?

Most physics teachers responded for type II calculators (about 85 percent or greater for all groups), while the response for types I and III ranged from 47 to 69 percent. Of those responding for type II, approximately 10 to 15 percent gave assistance, with the values for calculator types I and III ranging from 0 to 4 percent.

The responses in the chemistry questionnaire were very similar to those in the physics questionnaire, with a slightly higher response rate and greater indication that assistance was given with type II calculators (values ranged from about 20 to 30 percent).

In biology, about 80 to 90 percent of the instructors responded for type I calculators, 70 to 80 percent for type II, and about 33 percent for type III. Almost all those responding indicated that they do not provide any assistance.

Question 3. About what percent of your students use each type of calculator?

Most of the physics students used type II calculators. The same was true of chemistry, although slightly more used type I than in physics. In biology, very few students used calculators, and when they did it seemed to be just as likely to be a type I as a type II.

Question 4. Please list below any topics you teach for which calculator use is necessary. (In the physics questionnaire, this question read "If you teach special techniques for which calculator use is necessary, please list these techniques below.")

For physics, only 10 percent of the teachers in each group listed any topics. The other two questionnaires received a much higher response, ranging from 37 to 78 percent. This discrepancy in response rate may have been due to the difference in the phrasing of the question, which was due to an oversight by the authors in drafting the questionnaires.

In conjunction with question 4 instructors were asked to list any textbooks or other instructional materials they have found useful in teaching the topics they listed above. The response rates were as follows: physics, 1 percent; chemistry, about 40 percent, and biology, about 20 percent.

Appendix 2e lists by questionnaire the topics and texts mentioned by the respondents.

Question 5. Do you think that your students make intelligent use of the calculator?

In physics, about 60 percent responded Yes, and 20 percent No. Chemistry was roughly the same, while biology was about 45 percent Yes and 15 percent No. When asked to comment, a number of instructors indicated problems because of ignorance of significant figures, lack of knowledge about calculator capabilities, and overuse or dependence on calculators for simple calculations. A complete summary of the comments is given in Appendix 2f.

Question 6. Do you think students should be permitted to use calculators on the following College Board tests?

Instructors were asked to respond regarding the SAT-mathematical sections as well as the Achievement Tests and Advanced Placement Examinations in their respective subjects.

For the SAT, about 55 to 60 percent of the physics instructors who responded were against allowing type I calculators, while about 55 to 60 percent of the chemistry and biology instructors were in favor of their use. Close to half the physics instructors who responded were in favor of allowing type II calculators, and nearly half were not in favor of their use. Up to a 30 percent difference for chemists and a 20 percent difference for biologists existed between those in favor and those opposed to the use of type II calculators, with the majority in favor of their use. They all tended not to favor type III: 44 percent or more of each group were against their use, while only 19 percent or less were in favor.

The number of physics instructors who did not respond for types I or III for the subject tests was near 40 percent when averaged over all groups. Those who did

respond favored allowing use of types I and II (between 16 and 70 percent more said Yes than said No), and disapproved of type III (20 to 35 percent more said No).

In chemistry, the instructors expressed an overwhelming acceptance of type II on the subject tests; only 3 to 7 percent said No and 7 to 10 percent did not respond. They approved of type I (nearly 55 percent said Yes and 5 percent or fewer said No), and disapproved of type III (about 20 percent said Yes and 40 percent said No).

The biology instructors favored allowing types I and II on the subject tests, but not by as wide a margin as did physics and chemistry instructors (24 to 39 percent said No, and 45 to 62 percent said Yes). They also disapproved of type III (about 50 percent said No).

To summarize, instructors favored allowing calculator types I and II on the subject tests, and generally disapproved of type III. The responses for types I and II on the SAT were not very conclusive, but the instructors clearly disapproved of using type III.

Question 7. Do you have any concern about the use of calculators on standardized tests in general?

The percentage of instructors indicating concerns was fairly constant across groups and subjects (about 30 to 40 percent). Some major concerns were: students who bring information to the test in programmable memories, the equity issue, dependence on calculator use, and the nonmastery or deterioration of skills. A complete summary of concerns is given in Appendix 2g.

II. Microcomputers (Part B of Questionnaire)

The tabulated results for much of this part of the survey can be found in Appendix 2h.

Question 8. For each introductory course that you teach, check boxes to indicate in which areas microcomputers are used.

The percentage of instructors in a group indicating any microcomputer use varied greatly, from 23 to 73 percent, with the average percentage lowest for chemistry and highest for physics and biology. It should be recalled, however, that return rate for the questionnaire was least for biology and greatest for chemistry. In all three subjects, microcomputer use was greater in courses for majors than for nonmajors. There were differences, however, in the way computers are used in the disciplines. Drill, practice, and tutorial software are used most in chemistry and least in physics. Word processing is used most in biology and about the same in physics and chemistry. Recording and analysis of data is used most in physics and least in biology. The remaining uses are slight in all three disciplines.

Question 9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the computer?

The nonresponse rate to this question was high since it was answered only by those using microcomputers. Of those responding, the percentages of instructors answering Yes varied from 30 to 51 percent. In all disciplines, there was a tendency for instructors to give more assistance in the majors courses than in the nonmajors courses.

Question 10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?

In all groups, a majority of the instructors indicated that they have not made modifications in content in response to the availability of microcomputers. The negative responses ranged from 64 to 93 percent of the total number of responses to the question. Modifications were made most often in biology, least often in chemistry, and more for majors courses than nonmajors courses in all three disciplines.

Question 11. Please indicate the topics in each course that are particularly suited to the use of the microcomputer.

The response to this question ranged from 20 to 60 percent, with the biology instructors responding most often and the physics instructors least often. Appendix 2i lists the topics indicated for each questionnaire.

Question 12. What microcomputer makes and models are available at your school for student use?

Often, teachers responded to this question even if they didn't make use of computers themselves. The rates of response ranged from about 50 to 75 percent. Apple and IBM microcomputers were available most often, and with about equal frequency. A variety of other makes are represented; the models indicated for each questionnaire are listed in Appendix 2j.

Question 13. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

A great majority of the respondents did not replace any labs with simulations. In all the courses, only six instructors responded in the 26 to 50 percent range, and only one instructor (in physics) indicated a higher percentage.

Question 14. Are there laboratory or other skills that you feel can be assessed using microcomputer simulations that cannot be assessed using paper-and-pencil tests?

The percentage of instructors not responding or expressing no opinion on this question was high, ranging from 39 to 51 percent for the groups. For most of the groups, 15 to 19 percent of the instructors responded Yes. The exception was biology instructors at schools requiring Achievement Tests; 38 percent responded yes. Some teachers did not answer this question as intended, responding with topics instead of skills or responding from a teaching rather than an assessing point of view. Appendix 2k lists the topics indicated for each of the questionnaires.

Question 15. For each of the following tests, would you favor that microcomputer-administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Each of the three questionnaires inquired about the Achievement Tests and the AP Examinations for that subject. Again, the rate of nonresponse and No Opinion was high, ranging from about 40 percent for the biology tests to about 60 percent for the physics and chemistry tests. Among the questionnaires returned, the percentage of instructors answering Yes to this question was low, varying from 5 to 16 percent for the different tests.

After this question the teachers were invited to attach any examples of calculator or microcomputer materials that they use; only a few were received.

Question 16. Is a mainframe computer used in your course sequence?

The use of mainframe computers was not extensive. In courses for nonmajors, the percentage of respondents for the groups ranged from 4 to 14 percent, with the greatest use in chemistry. There was less variation in the courses for majors, where the percentages ranged from 15 to 19 percent.

Question 17. About what percent of computer use in your course sequence involves the mainframe computer?

A majority of the respondents in all the groups indicated that none of the computer use for their courses employed a mainframe, a response which was expected, given the results of question 16. Mainframe use was greatest for the chemistry instructors from institutions that are extensive Achievement Test users.

SUMMARY AND CONCLUSIONS

Nearly all the secondary school physics and chemistry teachers who responded did permit the use of calculators for all types of course work and at least some tests. They also favored allowing nonprogrammable calculators on College Board science examinations by margins between 7 to 1 and 22 to 1. Up to 21 percent of the teachers of biology and miscellaneous courses did not permit calculators on tests, and the biology teachers favored allowing nonprogrammable calculators on College Board biology examinations by only 2 to 1. This indicates that permitting such calculators on physics and chemistry exams would be very well received; permitting them on biology examinations would be less well received. Since few students seem to own programmable calculators, and since they were the least favored by teachers for use on exams, it seems much less appropriate to allow the use of programmable capabilities at this time.

Nearly all the postsecondary school physics and chemistry instructors who responded permit the use of nonprogrammable calculators on their tests, and a majority believed that the use of these calculators should be permitted on College Board science examinations. Most of their students used scientific calculators. The agreement between high school and college teachers on this issue suggests that it may be appropriate to permit students to use such calculators on College Board physics and chemistry examinations. The consensus of the instructors, however, seems to indicate that it may not be as appropriate to allow the use of programming capabilities.

For both course sequences, approximately 15 percent of the postsecondary biology instructors did not permit each of the three types of calculators on their tests, and few of their students use calculators. This, along with the fact that the instructors did not express strong approval of permitting the use of calculators on College Board biology examinations, indicates that such use may not be appropriate.

For all questionnaires, only half the secondary school respondents favored allowing use of nonprogrammable calculators on the SAT-mathematical sections. Once again, programmable calculators were the least favored by teachers. There was no clear consensus among postsecondary school instructors regarding use of nonprogrammable calculators on the SAT-mathematical sections, and they did not favor allowing programmable calculators. Thus it seems that it is less appropriate to allow calculator use on the SAT than the science examinations.

Currently, no type of calculator is allowed for the three College Board science Achievement Tests. The few calculations that are required on these tests usually involve basic arithmetic with simple numbers. Battery-operated hand calculators are allowed for the AP Examinations in chemistry and physics; however, the directions say that "all calculator memories must be cleared of programs and data," and students must sign a statement to the effect that they have complied with this directive.

Permitting hardware but not software eliminates any real or perceived advantages of those students who have programmable calculators over those who do not. Admittedly, this policy is not easy to monitor effectively; however, it does place the preprogramming of calculators or the storage of information in calculator memories in the category of cheating, along with other forms of crib notes. This policy has been in effect for six years, and there has been no major criticism by AP teachers or coordinators.

The survey data and the AP Physics and Chemistry experience suggest that the principal barriers to allowing use of calculators on all College Board science tests are administrative, not pedagogical. Almost all the concerns of chemistry and physics teachers about the use of calculators on standardized tests dealt with security (i.e., storage of preprogrammed information in memories) or equity (i.e., possible advantages to more affluent students with more sophisticated calculators). Biology teachers were also concerned about these issues but they were the only ones to raise any pedagogical concerns in significant numbers; 17 percent of them indicated that students are too dependent on or overuse calculators. Even so, a majority of the biology teachers said they would permit the use of simple and scientific calculators on the biology examinations.

The security and equity issues could best be addressed by allowing simple and scientific calculators rather than programmable calculators, by supplying a standard calculator to all registrants, or by adopting the AP Chemistry and Physics policy for all tests, but each of these avenues has administrative drawbacks which necessitate further consideration. Another approach is to allow all types of calculators, but try, by minimizing the amount of complex calculations required, to design the tests so that no single type of calculator would be more advantageous than any other type. Even if this could be done, however, the perception could remain that fairness would not be possible without standardization of calculator type.

For the various types of secondary school courses, between 34 and 53 percent of the teachers did not indicate any use of microcomputers in their courses. There was a tendency to think that the use of microcomputers on standardized tests would not assess skills that paper and pencil tests cannot assess; about 20 percent of those responding for physics, chemistry, and biology, and 12 percent of those responding for the miscellaneous science course questionnaire, thought that microcomputers could assess new skills. A slight majority of teachers believed that testing using microcomputer simulations should not be instituted; the percentage of respondents favoring such use ranged from 19 to 24 percent, while those not in favor ranged from 22 to 38 percent. Also, for the various postsecondary school course sequences (combining data for the colleges requiring Achievement Tests and the extensive users of Achievement Tests), between 28 and 72 percent of the instructors did not indicate any use of microcomputers in their courses, and overall about 20 percent of them thought that using microcomputer simulations on examinations would allow assessment of skills not previously tested.

Thus at the present time, there does not appear to be a strong interest by high school or college teachers for the introduction of microcomputer simulations in College Board tests in science. A minority of teachers thought that such simulations could test new skills. Although computers are enjoying significant and wide-ranging uses in some classrooms, they have not yet achieved such uses in a majority of classrooms. Such widespread availability of computers and their use by students would be a desirable characteristic for the efficient implementation of computers in national testing programs. However, considerable research in the realm of computer-assisted instruction and assessment is currently being conducted, and new developments in hardware and software keep the area of computer use in classrooms open to rapid change. Because there are potential advantages to using computers in standardized testing programs, the current situation should continue to be monitored closely.

APPENDIX 1a. Cover Letter

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609-921-9000
CABLE-EDUCTESTSVC
•
COLLEGE BOARD PROGRAMS

Dear Science Department Chairperson:

We need your help. The rapid increase in use of electronic calculators and microcomputers by students and the general population has posed serious questions for those who develop standardized tests. Has the science curriculum been changed by these devices? Should the use of calculators be allowed on standardized tests? The College Board's Sciences Advisory Committee needs responses to these and other pertinent questions from you and your teachers.

At the present time, calculators and other devices are not permitted in the testing room during the administration of College Board science and mathematics tests of the Admissions Testing Program. Calculators are allowed with the Advanced Placement Chemistry and Physics Examinations, but calculator memories must be cleared of both programs and data and no peripheral devices such as magnetic cards or tapes are permitted.

Periodically the Science Advisory Committee evaluates its position on such important issues. It will be discussing this issue and making recommendations to the College Board at its fall meeting. In order to arrive at an informed and reasonable policy concerning the use of calculators in the future, it is important that you and several of your teachers complete and return the enclosed questionnaires. Four questionnaires are enclosed; one each for biology, chemistry, physics and other courses. Please route the questionnaires to the appropriate staff for completion and then return all the questionnaires in the envelope provided. We may wish to list, in a report of the results, the names of the schools that participate in this survey, but we will not publish any results by individual school.

We hope you will agree to participate in this survey. In turn, we will be happy to share the results with you. Thank you for your time and effort in this endeavor.

Sincerely,

Naomi Martin

Naomi Martin
Chairperson, College Board Sciences Advisory Committee and Science Coordinator,
Horry County Public Schools, SC

APPENDIX 1b. Hand Calculator and Microcomputer Surveys

PHYSICS COURSES

1986

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and computer use among secondary school science students. The Committee also needs to solicit the opinions of secondary school teachers related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the schools that participate in the survey but we will not publish any results by individual schools.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. Most of the questions can be answered by checking boxes, so the questionnaire should not take long to complete.

Please return the questionnaire to your department chairperson. We will share a report on the results of the survey with all who request such a report.

Thank you.

APPENDIX 1b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I. Simple. Arithmetic functions only. Usually cost less than $10.
II. Scientific. Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III. Programmable. Usually cost more than $20.

For each physics course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply)	Regular Physics			AP Physics ___ Physics B ___ Physics C		
1. Hand calculators are	Calculator Type I	II	III	Calculator Type I	II	III
NOT permitted for any purpose						
permitted for use in doing classwork						
permitted for use in doing homework						
permitted for use in doing laboratory work						
NOT permitted during tests						
permitted during some but not all tests						
permitted or required during all tests						

2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percentage of your students own each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

5. If you teach special techniques that make use of the calculator, please list these techniques below

Regular Physics

Topics _____

_____

_____

AP Physics

Topics _____

_____

_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

6. If calculators are permitted in your classes, are they provided by the school district?

Yes_____ No_____

7. Do you think students should be permitted to use calculators on the following tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Physics Achievement Test						
AP Physics Examination						

8. If calculator use were permitted on any of the tests listed in question 7, would you change your calculator policy for any of your physics courses?

Yes_____ No _____

If yes, please indicate course and explain:

_____

_____

_____

_____

APPENDIX 1b. (continued)

9. If calculator use were permitted on any of the tests listed in question 7 would you change the content of your physics courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

10. If calculator use were permitted on any of the tests listed in question 7 would you change your method of teaching in any of your physics courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

11. Do you have any concerns about the use of calculators on standardized tests in general?

Yes_____ No_____

Please explain your concerns. (Attach additional pages if necessary)

_____

_____

_____

_____

_____

APPENDIX 1b. (continued)

Part B: Microcomputers

12. For each course, check boxes to indicate how microcomputers are used in your classes. (Check all boxes that apply.)

	Regular Physics	AP Physics __Physics B __Physics C
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher written programs. If so, what language?		
Use of student written programs. If so, what language?		
Communication with information services or data bases		

13. If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?

Yes		
No		
If yes, how many hours per year?		

14. Has the course been modified to include topics that are particularly suited to the use of the computer?

Yes		
No		

15. Please indicate the topics in each course that are particularly suited to the use of the computer. (attach additional pages if necessary)

16. What computer makes and models are available at your school for student use?

17. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

18. Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

Yes ___ No ___ No opinion ___

Please explain:

_____

_____

_____

19. For each of the following tests, would you favor that computer administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Physics Achievement Test	Yes ___	No ___	No opinion ___
AP Physics B Examination	Yes ___	No ___	No opinion ___
AP Physics C Examination	Yes ___	No ___	No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes

20. Are you interested in writing multiple-choice test questions for which calculators can be effectively used or that test skills that can best be assessed using a calculator? Yes ___ No ___

21. Would you like to receive a copy of the questionnaire results?
Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ Secondary School Code # / / / / / /

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by December 15, 1986 to:

Will Pfeiffenberger, 25-E Educational Testing Service, Princeton, NJ 08541

APPENDIX 1b. (continued)

HAND CALCULATOR AND MICROCOMPUTER SURVEY

CHEMISTRY COURSES

1986

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and computer use among secondary school science students. The Committee also needs to solicit the opinions of secondary school teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the schools that participate in the survey but we will not publish any results by individual schools.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. Most of the questions can be answered by checking boxes, so the questionnaire should not take long to complete.

Please return the questionnaire to your department chairperson. We will share a report on the results of the survey with all who request such a report.

Thank you.

APPENDIX 1b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I. Simple. Arithmetic functions only. Usually cost less than $10.
II. Scientific. Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III. Programmable. Usually cost more than $20.

For each chemistry course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply)

1. Hand calculators are

	Regular Chemistry			AP Chemistry		
	Calculator Type			Calculator Type		
	I	II	III	I	II	III
NOT permitted for any purpose						
permitted for use in doing classwork						
permitted for use in doing homework						
permitted for use in doing laboratory work						
NOT permitted during tests						
permitted during some but not all tests						
permitted or required during all tests						

2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percentage of your students own each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

5. Please list below any topics you teach that make use of the calculator.

Regular Chemistry

Topics _____

_____

_____

AP Chemistry

Topics _____

_____

_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

6. If calculators are permitted in your classes, are they provided by the school district?

Yes_____ No_____

7. Do you think students should be permitted to use calculators on the following tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Chemistry Achievement Test						
AP Chemistry Examination						

8. If calculator use were permitted on any of the tests listed in question 7, would you change your calculator policy for any of your chemistry courses?

Yes_____ No _____

If yes, please indicate course and explain:

_____

_____

_____

_____

9. If calculator use were permitted on any of the tests listed in question 7 would you change the content of your chemistry courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

10. If calculator use were permitted on any of the tests listed in question 7 would you change your method of teaching in any of your chemistry courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

11. Do you have any concerns about the use of calculators on standardized tests in general?

Yes_____ No_____

Please explain your concerns. (Attach additional pages if necessary)

_____

_____

_____

_____

_____

APPENDIX 1b. (continued)

Part B: Microcomputers

12. For each course, check boxes to indicate how microcomputers are used in your classes. (Check all boxes that apply.)

	Regular Chemistry	AP Chemistry
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher written programs. If so, what language?		
Use of student written programs. If so, what language?		
Communication with information services or data bases		

13. If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?

Yes		
No		
If yes, how many hours per year?		

14. Has the course been modified to include topics that are particularly suited to the use of the computer?

Yes		
No		

15. Please indicate the topics in each course that are particularly suited to the use of the computer. (attach additional pages if necessary)

16. What computer makes and models are available at your school for student use?

17. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

18. Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

Yes ___ No ___ No opinion ___

Please explain:

_____

_____

_____

19. For each of the following tests, would you favor that computer administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Chemistry Achievement Test Yes ___ No ___ No opinion ___
AP Chemistry Examination Yes ___ No ___ No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes

20. Are you interested in writing multiple-choice test questions for which calculators can be effectively used or that test skills that can best be assessed using a calculator? Yes ___ No ___

21. Would you like to receive a copy of the questionnaire results?
Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ Secondary School Code # / / / / / /

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by December 15, 1986 to:

Will Pfeiffenberger, 25-E Educational Testing Service, Princeton, NJ 08541

HAND CALCULATOR AND MICROCOMPUTER SURVEY

BIOLOGY COURSES

1986

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and computer use among secondary school science students. The Committee also needs to solicit the opinions of secondary school teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the schools that participate in the survey but we will not publish any results by individual schools.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. Most of the questions can be answered by checking boxes, so the questionnaire should not take long to complete.

Please return the questionnaire to your department chairperson. We will share a report on the results of the survey with all who request such a report.

Thank you.

APPENDIX 1b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I. Simple. Arithmetic functions only. Usually cost less than $10.
II. Scientific. Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III. Programmable. Usually cost more than $20.

For each biology course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply)

1. Hand calculators are	Regular Biology Calculator Type I	Regular Biology Calculator Type II	Regular Biology Calculator Type III	AP Biology Calculator Type I	AP Biology Calculator Type II	AP Biology Calculator Type III
NOT permitted for any purpose						
permitted for use in doing classwork						
permitted for use in doing homework						
permitted for use in doing laboratory work						
NOT permitted during tests						
permitted during some but not all tests						
permitted or required during all tests						

2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percentage of your students own each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

5. Please list below any topics you teach that make use of the calculator.

Regular Biology

Topics _____

_____

_____

AP Biology

Topics _____

_____

_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

6. If calculators are permitted in your classes, are they provided by the school district?

Yes_____ No_____

7. Do you think students should be permitted to use calculators on the following tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Biology Achievement Test						
AP Biology Examination						

8. If calculator use were permitted on any of the tests listed in question 7, would you change your calculator policy for any of your biology courses?

Yes_____ No _____

If yes, please indicate course and explain:

_____

_____

_____

_____

APPENDIX 1b. (continued)

9. If calculator use were permitted on any of the tests listed in question 7 would you change the content of your biology courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

10. If calculator use were permitted on any of the tests listed in question 7 would you change your method of teaching in any of your biology courses?

Yes _____ No _____

Please indicate the course and explain these changes

_____

_____

_____

_____

_____

11. Do you have any concerns about the use of calculators on standardized tests in general?

Yes_____ No_____

Please explain your concerns. (Attach additional pages if necessary)

_____

_____

_____

_____

_____

APPENDIX 1b. (continued)

Part B: Microcomputers

12. For each course, check boxes to indicate how microcomputers are used in your classes. (Check all boxes that apply.)

	Regular Biology	AP Biology
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher written programs. If so, what language?		
Use of student written programs. If so, what language?		
Communication with information services or data bases		

13. If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?

Yes		
No		
If yes, how many hours per year?		

14. Has the course been modified to include topics that are particularly suited to the use of the computer?

Yes		
No		

15. Please indicate the topics in each course that are particularly suited to the use of the computer. (attach additional pages if necessary)

16. What computer makes and models are available at your school for student use?

17. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

18. Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

Yes ___ No ___ No opinion ___

Please explain:

_____

_____

_____

19. For each of the following tests, would you favor that computer administered simulations designed to assess laboratory skills be given in conjunction with the test?

Biology Achievement Test Yes ___ No ___ No opinion ___
AP Biology Examination Yes ___ No ___ No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes

20. Are you interested in writing multiple-choice test questions for which calculators can be effectively used or that test skills that can best be assessed using a calculator? Yes ___ No ___

21. Would you like to receive a copy of the questionnaire results?
Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ Secondary School Code # / / / / / /

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by December 15, 1986 to:

Will Pfeiffenberger, 25-E Educational Testing Service, Princeton, NJ 08541

HAND CALCULATOR AND MICROCOMPUTER SURVEY

SCIENCE COURSES OTHER THAN BIOLOGY, CHEMISTRY, OR PHYSICS

1986

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and computer use among secondary school science students. The Committee also needs to solicit the opinions of secondary school teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the schools that participate in the survey but we will not publish any results by individual schools.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. Most of the questions can be answered by checking boxes, so the questionnaire should not take long to complete.

Please return the questionnaire to your department chairperson. We will share a report on the results of the survey with all who request such a report.

Thank you.

APPENDIX 1b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I. Simple. Arithmetic functions only. Usually cost less than $10.
II. Scientific. Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III. Programmable. Usually cost more than $20.

For any two science courses that you teach, other than biology, chemistry, or Physics, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply)

1. Hand calculators are	Course I: __ General Sci. __ Physical Sci. __ Earth Sci. __ Other _____ — Calculator Type I	II	III	Course II: __ General Sci. __ Physical Sci. __ Earth Sci. __ Other _____ — Calculator Type I	II	III
NOT permitted for any purpose						
permitted for use in doing classwork						
permitted for use in doing homework						
permitted for use in doing laboratory work						
NOT permitted during tests						
permitted during some but not all tests						
permitted or required during all tests						

2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percentage of your students own each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?

	Course I (From page 1) Calculator Type			Course II (From page 1) Calculator Type		
	I	II	III	I	II	III
less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

5. Please list below any topics you teach that make use of the calculator.

Course I _____ Course II _____

Topics _____ Topics _____

_____ _____

_____ _____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

6. If calculators are permitted in your classes, are they provided by the school district?

Yes_____ No_____

7. Do you think students should be permitted to use calculators on the SAT Mathematics Sections?

Type of Calculator:

Type I: Yes ___ No ___

Type II: Yes ___ No ___

Type III: Yes ___ No ___

8. Do you have any concerns about the use of calculators on standardized tests in general?

Yes_____ No_____

Please explain your concerns. (Attach additional pages if necessary)

_____

_____

_____

_____

_____

APPENDIX 1b. (continued)

Part B: Microcomputers

9. For each of the two courses from part A, check boxes to indicate how microcomputers are used in your classes (Check all boxes that apply.)

	Course I	Course II
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher written programs. If so, what language?		
Use of student written programs. If so, what language?		
Communication with information services or data bases		

10. If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?

Yes		
No		
If yes, how many hours per year?		

11. Has the course been modified to include topics that are particularly suited to the use of the computer?

Yes		
No		

12. Please indicate the topics in each course that are particularly suited to the use of the computer. (attach additional pages if necessary)

13. What computer makes and models are available at your school for student use?

14. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

15. Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

Yes ___ No ___ No opinion ___

Please explain:

_____

_____

_____

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes

16. Are you interested in writing multiple-choice test questions for which calculators can be effectively used or that test skills that can best be assessed using a calculator? Yes ___ No ___

17. Would you like to receive a copy of the questionnaire results?
Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ Secondary School Code # / / / / / /

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by December 15, 1986 to:

Will Pfeiffenberger, 25-E Educational Testing Service, Princeton, NJ 09541

APPENDIX 1c. FOLLOW-UP POSTCARD

In November, a survey on calculator and computer use in high school science courses was mailed to your department, but so far no response has been received from your school. The survey was sponsored by the College Board Sciences Advisory Committee and the questionnaire included questions on the use of calculators on national standardized tests. The experiences and opinions of all the teachers at the schools in the sample are valued, so the deadline for returning questionnaires has been extended to January 31. If you no longer have the questionnaires (there was one each for Biology, Chemistry, Physics, and Other courses) and still wish to respond to the survey, you may call collect to Mr. Will Pfeiffenberger (609) 734-1466 to receive additional questionnaires. Thank you for your attention.

APPENDIX 1d. Responses for Part A: Hand Calculators

Responses for Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I. Simple. Arithmetic functions only. Usually cost less than $10.
II. Scientific. Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III. Programmable. Usually cost more than $20.

Physics: 155 questionnaires returned, 37 responses for AP

For each physics course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply.)		Regular Physics			AP Physics 17 Physics B 8 Physics C		
		Calculator Type			Calculator Type		
1. Hand calculators are		I	II	III	I	II	III
NOT permitted for any purpose		0	3	10	0	1	0
permitted for use in doing classwork		80	135	79	17	30	23
permitted for use in doing homework		82	138	81	17	29	22
permitted for use in doing laboratory work		82	139	82	17	30	23
NOT permitted during tests		0	1	17	0	1	4
permitted during some but not all tests		12	21	11	2	5	5
permitted or required during all tests		76	130	57	18	28	17
2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?	Yes	35	91	21	8	23	7
	No	48	45	45	12	10	13
3. About what percentage of your students own each type of calculator?	less than 25%	46	4	80	5	1	18
	25% - 49%	16	17	5	0	1	1
	50% - 79%	8	48	3	2	7	3
	80% - 99%	9	53	3	1	15	0
	100%	4	23	1	0	6	2
4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?	less than 25%	43	4	69	5	1	15
	25% - 49%	18	11	4	0	0	1
	50% - 79%	8	51	4	2	7	2
	80% - 99%	7	52	1	1	12	0
	100%	7	27	5	0	9	3

APPENDIX 1d. (continued)

Chemistry: 154 Questionnaires returned, 62 responses for AP

For each chemistry course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply)

		Regular Chemistry			AP Chemistry		
		Calculator Type			Calculator Type		
1.	Hand calculators are	I	II	III	I	II	III
	NOT permitted for any purpose	5	3	13	0	1	2
	permitted for use in doing classwork	110	123	54	34	51	27
	permitted for use in doing homework	118	132	63	35	54	31
	permitted for use in doing laboratory work	118	131	62	35	54	30
	NOT permitted during tests	6	5	23	0	1	7
	permitted during some but not all tests	25	27	15	6	7	4
	permitted or required during all tests	101	114	41	31	53	22
2.	If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?						
	Yes	57	83	11	11	29	6
	No	54	43	34	17	23	14
3.	About what percentage of your students own each type of calculator?						
	less than 25%	38	19	63	12	1	23
	25% - 49%	29	31	1	6	16	3
	50% - 79%	21	34	2	3	14	2
	80% - 99%	21	28	4	2	13	0
	100%	8	17	0	1	17	3
4.	If calculators are permitted in your classes, about what percentage of your students use each type of calculator?						
	less than 25%	36	21	59	15	1	22
	25% - 49%	33	29	2	6	14	4
	50% - 79%	19	36	3	2	16	1
	80% - 99%	21	28	6	1	15	1
	100%	8	15	1	1	15	3

APPENDIX 1d. (continued)

Biology: 151 questionnaires returned, 70 responses for AP

Part A: Hand Calculators

For each biology course that you teach, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply.)	Regular Biology			AP Biology		
	Calculator Type			Calculator Type		
1. Hand calculators are	I	II	III	I	II	III
NOT permitted for any purpose	16	11	17	3	3	5
permitted for use in doing classwork	91	60	33	39	46	26
permitted for use in doing homework	102	71	43	41	47	29
permitted for use in doing laboratory work	97	68	37	38	48	25
NOT permitted during tests	23	22	20	7	8	8
permitted during some but not all tests	39	19	11	14	14	7
permitted or required during all tests	46	33	16	22	32	13
2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?						
Yes	16	11	2	4	9	4
No	109	60	46	38	37	28
3. About what percentage of your students own each type of calculator?						
less than 25%	39	39	49	4	8	25
25% - 49%	27	23	3	12	12	4
50% - 79%	36	19	1	9	17	2
80% - 99%	9	8	0	9	11	0
100%	6	0	0	5	4	0
4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?						
less than 25%	57	55	52	23	20	27
25% - 49%	23	17	2	4	5	4
50% - 79%	22	7	0	6	15	1
80% - 99%	9	5	0	5	8	0
100%	2	2	0	2	4	0

APPENDIX 1d. (continued)

Miscellaneous: 119 Questionnaires returned, representing 161 courses

For any two science courses that you teach, other than biology, chemistry, or Physics, check the boxes that describe the use of each type of hand calculator in your classes. (Check all that apply.)

All Courses

17 General Sci.
54 Physical Sci.
51 Earth Sci.
30 Other _____
9 not checked

1. Hand calculators are	Calculator Type I	II	III
NOT permitted for any purpose	12	7	11
permitted for use in doing classwork	111	68	32
permitted for use in doing homework	123	77	37
permitted for use in doing laboratory work	116	70	33
NOT permitted during tests	25	17	21
permitted during some but not all tests	32	24	7
permitted or required during all tests	70	41	19

2. If calculators are permitted in any of your classes, is any class time devoted to teaching or assisting students in the use of the calculator?				
	Yes	35	24	3
	No	95	46	38

3. About what percentage of your students own each type of calculator?			
less than 25%	52	56	59
25% - 49%	24	17	0
50% - 79%	38	3	0
80% - 99%	17	7	0
100%	2	3	0

4. If calculators are permitted in your classes, about what percentage of your students use each type of calculator?			
less than 25%	58	61	46
25% - 49%	28	11	0
50% - 79%	23	3	0
80% - 99%	11	9	0
100%	6	1	0

APPENDIX 1d. (continued)

5. Please list below any topics you teach that make use of the calculator.

Physics 28, Chemistry 131, Biology 109, Miscellaneous 89

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

Physics 19, Chemistry 54, Biology 38, Miscellaneous 33
(Topics and texts are listed in Appendix III.)

6. If calculators are permitted in your classes, are they provided by the school district?

Physics	Yes	14	No	137	No response	6
Chemistry	Yes	13	No	136	No response	5
Biology	Yes	4	No	130	No response	18
Miscellaneous	Yes	9	No	102	No response	8

7. Do you think students should be permitted to use calculators on the following tests? (B indicates blank; i.e., no response.)

	Type I			Type II			Type III		
	Yes	No	B	Yes	No	B	Yes	No	B
Physics									
SAT Mathematics Sections	42	57	56	74	61	22	18	76	63
Physics Achievement Test	87	11	57	136	11	10	47	50	60
AP Physics Examination	85	12	58	131	12	14	48	50	59
Chemistry									
SAT Mathematics Sections	59	57	38	67	57	30	18	79	57
Chemistry Achievement Test	116	7	31	127	10	17	34	63	57
AP Chemistry Examination	108	5	41	129	7	18	33	63	58
Biology									
SAT Mathematics Sections	60	52	40	55	52	45	16	63	73
Biology Achievement Test	76	46	29	67	44	40	28	57	67
AP Biology Examination	82	36	33	74	41	36	30	55	67
Miscellaneous									
SAT Mathematics Sections	50	48	21	47	51	21	20	62	37

APPENDIX 1d. (continued)

8. If calculator use were permitted on any of the tests listed in question 7, would you change your calculator policy for any of your courses?

Physics	Yes	5	No	147	No response	5
Chemistry	Yes	8	No	141	No response	5
Biology	Yes	12	No	127	No response	13

9. If calculator use were permitted on any of the tests listed in question 7 would you change the content of your courses?

Physics	Yes	4	No	149	No response	4
Chemistry	Yes	4	No	146	No response	4
Biology	Yes	12	No	130	No response	10

10. If calculator use were permitted on any of the tests listed in question 7 would you change your method of teaching in any of your courses?

Physics	Yes	9	No	143	No response	5
Chemistry	Yes	6	No	144	No response	4
Biology	Yes	12	No	128	No response	12

11. Do you have any concerns about the use of calculators on standardized tests in general?

Physics	Yes	55	No	96	No response	6
Chemistry	Yes	45	No	105	No response	4
Biology	Yes	55	No	85	No response	12
Miscellaneous	Yes	42	No	70	No response	7

APPENDIX 1d. (continued)

Types of Courses Indicated in the "Other" Category
of the Miscellaneous Questionnaire

Anatomy
Anatomy and Physiology
Animal Behavior/Ecology
Astronomy (2)
Biology
Chemistry and the Community
Ecology
Environmental Science
Field Ecology
Geology (3)
Global Science
Horticulture
Integrated Science
Life Science
Marine Biology
Math (2)
Meteorology
Physiology
Science and Social Issues
Science/Technology
Not specified (4)

APPENDIX 1e. Topics Involving Calculator Use and Related Texts

(From Question 5)

Physics

Regular courses

Math and General Topics

- Trigonometric functions (14)
- Scientific notation/exponents/ exponential equations (10)
- Vectors (6)
- Problem solving (5)
- Logarithms(3)
- Statistics(3)
- Curve fitting/ regression analysis (3)
- Successive approximation
- Green's Theorem
- Radian measurement
- Dimensional analysis
- Coordinate conversion - polar/rectangular

Physics Topics

- Mechanics(2)
- Forces
- Dynamics
- Harmonic oscillators
- Electricity
- Electromagnetism
- Astronomy
- Optics
- Waves
- Snell's Law
- Gas laws
- Heat exchange
- Radioactive decay
- Spectrometry

AP Courses

Math and General Topics

- Vectors(4)
- Trigonometric functions
- Logarithms
- Exponents
- Statistics
- Linear regression
- Problem solving

Physics Topics

- Motion
- Forces
- Rotation
- Electricity
- Thermodynamics
- Relativity

Texts and Other Materials

Giancoli, Physics; 2nd ed.
Peters, Problem Solving for Chemistry; Chapter 1
Williams, Trinklein, and Metcalf, Modern Physics; Holt (4)
Bobby J. Woodruff, Terms, Tables, and Skills for the Physical Sciences; Silver Burdett
Chemistry: A Modern Course; Merrill
Mathematics on Keys; Texas Instruments
Physics: Its Methods and Meanings; Allyn and Bacon
Physics: Principles and Problems; Merrill
Addison-Wesley's new Chemistry Book
Calculator owner's manual
The Great International Math on Keys Book
Hewlett-Packard user's manual
Principles and Problems in Physics
Student Calculator Math Book

* (n) represents the number of times the topic or text was mentioned. No number means the topic or text was mentioned only once. Where appropriate, related topics are grouped together, and generally listed by frequency of occurrence.

APPENDIX 1e. (continued)

Chemistry

Regular Courses

Math and General Topics
- All Math work (25)
- Scientific notation (10)
- Metrics (4)
- Problem solving (4)
- Unit conversion (3)

Chemistry Topics
- pH (30)
- pK
- Equilibrium constant (30)
- Acid-base equilibrium (16)
- K_{sp} (6)
- K_A (3)
- K_W
- Kinetics (4)
- Rates
- Gas Laws (63)
- Stoichiometry (72)
- Moles/mole conversions (35)
- Percent composition (14)
- Molecular/atomic weights (5)
- Chemical formulas/equations (7)
- Titration (4)
- Hydrolysis
- Thermodynamics/heat/ enthalpy (16)
- Simple ratios
- Dimensional analysis
- Significant figures
- Lab data acquisition (6)
- Measurement error
- Thermochemistry (4)
- Calorimetry (4)
- Electrochemistry (5)
- Ionization
- Molarity/molality/ solution concentrations (24)
- Solubility
- Molar volumes
- Ion concentrations
- Redox (2)
- Colligative properties (3)
- Nuclear chemistry
- Quantum/atomic theories (2)
- Spectra
- Density (6)
- Mass-mass problems (4)
- Mass-volume problems (3)
- Volume-volume problems

AP Courses

Math and General Topics
- All Math work (3)
- Problem solving
- Scientific notation (2)

Chemistry Topics
- pH (13)
- pK
- Buffers (2)
- Equilibrium constants (26)
- Acid-base equilibrium (11)
- K_{sp} (5)
- K_A (3)
- Kinetics (14)
- Rates (2)
- Gas laws (19)
- Stoichiometry (26)
- Moles/mole conversions (9)
- Percent composition (3)
- Chemical formulas/equations (2)
- Titration
- Hydrolysis
- Raoult's Law
- Lab data acquisition (2)
- Dimensional analysis
- Thermodynamics (16)
- Thermochemistry (5)
- Calorimetry (2)
- Spontaneity of reactions
- Gibbs-Helmholtz equation
- Clapeyron equation
- Electrochemistry (5)
- Electrode potentials
- Ionization
- Molarity/molality/ solution concentrations (8)
- Solubility (2)
- Nuclear decay (4)
- Isotope abundance
- Spectra
- Mass-energy relation
- Redox (5)
- Density (2)

Chemistry Texts and Other Materials

Aikerton, Gray, Aarenburg, Chemical Principles
Brady and Holum, Fundamentals of Chemistry
Brady and Humiston, General Chemistry - Principles and Structure
Darin, Chemistry The Study of Matter (5)
Drago, General Chemistry - Problem Solving I and II
Globe, Concepts in Modern Chemistry
Butler and Grosser, (Relevant problems)
Heath, College Chemistry
Hinies, Solving Problems in Chemistry
Margolis, Equilibrium Calculations
Masterson, Chemistry
Masterson et al., Chemical Principles (4)
McQuarrie and Rock, College Chemistry
McQuarrie and Rock, General Chemistry; Freeman
Metcalf et al., Modern Chemistry (4)
Michels, Basic Math Approach to Chemistry
Nebergall, Chemistry
Sienko and Plane, Chemical Principles and Properties (2)
Smoot, Chemistry (2)
Smoot, Price, and Smith, Chemistry: A Modern Course; Merrill (9)
Smoot et al., Chemistry: Laboratory Course; Merrill
Sorum, General Chemistry Problems
D. B. Summers, The Chemistry Handbook
Glen Tilbury, Problem Solving in Chemistry (2)
Zumdahl, Chemistry
Chemical Principles
Chemistry (2)
Chemistry; Addison-Wesley
Chemistry; Silver Burdett
Chemistry: An Experimental Science
Chemistry Problems and How to Solve Them; Harper and Row
Foundations of Chemistry; Holt
Modern Chemistry; Holt (8)
Chemistry Experimental Foundations; Prentice Hall
Manual for each student's calculator
Modern Chemistry (6)
Prentice Hall's CSC Chemistry series filmstrips #881, 883, 885, 898
Qualitative Analysis
Sienko, Paperback on equilibrium
TI-30 manual
TI large manuals - TI-35 and 55

Biology

Regular Courses
Math and General Topics

- Metric system (10)
- Data analysis (7)
- Measurements (3)
- Graphing
- Conversions (3)
- Probability (6)
- Statistics (8)
- Percent error (2)

APPENDIX 1e. (continued)

Biology Topics
- Population problems (17)
- Genetics (64)
- Evolution (2)
- Ecology (9)
- Growth rates (4)
- Chemistry (4)
- Molecular weights
- Percent solutions
- Volume calculations
- Temperature changes
- pH
- Reaction times
- Biochemistry
- Cell diffusion
- Nutrient lab
- Calories lab
- Microscopy/ microscope calculations (7)
- Microbiology
- Cell theory
- Blood count
- Percent changes in plasmolysis
- Metabolism
- Physiology measurements
- Protein synthesis

AP Courses

Math and General topics
- Statistics (16)
- Probability (5)
- Data analysis (5)
- Data collection
- Temperature conversion

Biology Topics
- Chemistry (4)
- Solutions
- Moles
- Chromatography (2)
- Calorimetry
- Enzyme kinetics
- Diffusion
- Gas laws/vital capacities (2)
- Biochemistry (3)
- Microscopy
- Microbiology
- Blood counts
- Physiology
- Metabolism
- Cellular respiration
- Population problems (10)
- Genetics (33)
- Evolution (4)
- Hardy-Weinberg Law (4)
- Ecology (5)
- Behavior
- Growth curve
- Soil survey
- Anatomy
- Dichotomous key
- RF rates (2)

Texts and Other Materials

Alexander et al., Biology; Silver Burdett
Arms and Camp, Biology; Saunders (5)
Helena Curtis, Biology; Worth (5)
Harcourt, Biology
Hartl, Human Genetics; Harper and Row
Keeton, Biology (2)
Kimball, Biology (2)
Oram-Hummer and Smoot, Biology - Living Systems (2)
Slesnick et al., Biology; Scott, Foresman (also lab manual)
Kirk
Tortora, Principles of Physiology/Anatomy
Villee, Biology
Villee and Davis, Biology
Volpe et al., Biological Science; Prentice Hall
Wallace, Biology - The Science of Life

APPENDIX 1e. (continued)

Biology Texts and Other Materials (Continued)

Better Homes and Gardens' Family Medical Guide
Biological Science: Interaction of Experiments and Ideas
BSCS green version
BSCS black version
Concepts in Modern Biology (text and lab manual)
Interaction of Experiments and Ideas
Living Systems; Merrill
Modern Biology (3)
Biology - The Study of Life; Allyn Bacon
Modern Biology; Holt
Prentice-Hall laboratory manual

Miscellaneous

Math and General Topics
- Math (8)
- Metrics (7)
- Conversions (5)
- Scientific notation (4)
- Gradient (2)
- Trigonometry
- Volumes (9)
- Percent error (5)
- Statistics (2)
- Probability
- Graphing

Science Topics
- Density (45)
- Specific gravity (2)
- Physics (2)
- Mechanics (2)
- Motion (23)
- Newton's Laws (2)
- Force (10)
- Buoyancy
- Orbits (3)
- Gravity
- Torque
- Simple machines (3)
- Work/power (10)
- Energy (6)
- Thermodynamics/heat (10)
- Specific heat
- Waves (7)
- Electricity (4)
- Light (3)
- Atomic physics (3)
- Nuclear physics (2)
- Chemistry (7)
- Moles (3)
- Molarity
- Percent composition (4)
- Chemical formulas
- Gas laws
- Pressure (3)
- Anatomy
- Calculating BMR
- Population studies
- Genetics
- Earth science
- Earth measurement (5)
- Earthquakes (3)
- Dating
- Tides
- Weathering
- Mining geology
- Stratigraphic mapping
- Meteorology/weather (6)
- Humidity (4)
- Average rainfall
- Dewpoints
- Astronomy (12)
- Map reading (2)
- Distances
- Feed ratios
- Lumber/timber scaling
- Fertilizer/chemical rates
- Labs on soils
- Salinity
- Pollution

APPENDIX 1e. (continued)

Miscellaneous Texts and Other Materials

Abell, Exploration of the Universe
Anthony, Anatomy and Physiology
Ginn, Physical Science
Gross, Introductory Oceanography
Heath, Earth Science
Heimler and Price, Focus on Physical Science
Lutgens and Tarbuck, The Atmosphere; Prentice Hall
Namowitz and Spaulding, Earth Science (2)
Namowitz and Spaulding, Oceanography
Namowitz and Spaulding, Naked Eye Astronomy
Astronomy - From the Earth to the Universe
Earth Science; Prentice Hall
Earth Science : A Study of a Changing Planet
E. S. Cebco (Earth Science course)
ESCP - Exploring Earth Science
Focus on Earth Science
Focus on Physical Science; Merrill
Forests and Forestry
General Science; Merrill
Introduction to Physical Science
Investigating the Earth; American Geological Institute (2)
Modern Earth Science
Modern Physical Science; Holt, Rinehart, Winston (2)
Modern Physical Science
Our Chemical and Physical World; Merrill
Physical Science; Holt
IPS text
Merrill Science series
Stockman's Handbook
Teacher-written material (2)
Technology Infusion Project

APPENDIX 1f. Comments Regarding Changes in Classroom Practices in Response to Calculator Use on Standardized Tests

Question 8. Would you change your calculator policy?

Physics

Would encourage their use more than I do now.
Would encourage and teach thoroughly the use of the calculator to obtain better scores.
Would teach some methodology.
For both courses I would spend more time on instruction to use calculators.
Would probably spend some time helping the students discover the most efficient ways of using calculator for basic computation.

Chemistry

I think we would allow the use of calculators if our policy was more restrictive than the policy regarding the tests. However, we allow calculators in all science courses, including chemistry.
I might stress their importance and use more.
Some use in regents would change to all the time. (Author's note: This seems to mean that if they were allowed on the regents exam, they would be allowed at all times in this class.)
All courses to prepare students
I would teach my students the proper way to work problems with their calculator, and require that all students have a type II calculator for use during class.
To include other problems more mathematically oriented

Biology

If they are acceptable on all levels then I feel that I could not refuse their use in class for all assignments and work.
I'd allow them on class exams in AP if a calculator was ever necessary.
Would increase amount of deductive material needed to answer problems. Would increase the thought process involved in obtaining the correct formulas etc.
AP Biology -- Strongly suggest availability of type II or even III calculator.
AP -- If questions change so that some require calculators I will have to restructure my tests to provide experience in handling data of a more complex nature.
They could use it in tests.
Genetics - I would teach use and insure availability of calculators.
Regular course - I normally do not get that involved in math at the basic level - I teach the ecological approach.

APPENDIX 1f. (continued)

Question 9. Would you change your course content?

Physics

Regents Physics - I would probably make the problems more mathematically involved.
Would put more emphasis on calculation techniques and general algebra.
Would teach their use through trigonometry.
Would teach slope determination on programmable calculator; also unit conversions, projectile calculations, integration (area under curve).

Chemistry

Perhaps put more stress on use of significant figures in answers.
Change test length for each topic in calculations.
I would incorporate calculator literacy on each topic discussed in question 5.
To include other problems more mathematically oriented

Biology

I would REQUIRE all students in cp Biology to have calculators (type II) which they would have to supply. This is now required of honors and AP biology students.
In academic Biology I would give mathematically harder problems in order to prepare these students for the types of problems they would encounter on tests.
Calculator use in a first level course is very limited. More math would need to be introduced into courses.
Some use would be appropriate in lab -- chi squared analysis of data. I do not test on this but would have to if AP began using it.
Would introduce more analytical labs.
Would introduce more in-depth study.
Would assume use of calculators, so questions would reflect more complex numerical processes.
Would introduce more statistical and/or probability problems and experiments.
Would give specific calculator use instructions.

Question 10. Would you change your method of teaching?

Physics

I might show students how to use calculators, e.g. trig functions, scientific notation.
Usually spend a week on exponential functions without calculators -- could cut down and use time elsewhere.
Would teach their use through trig.
Would spend more time making sure the students were getting maximum benefit of calculators in all problem situations.
I would have to spend more time teaching calculator use and less on course content and concepts. BAD BUSINESS! DON'T ALLOW CALCULATOR USE ON NATIONAL TESTS!
Rather than having calculator instruction as we go, I would have a unit devoted to the use of calculators.
I'd have to explain to my classes how to use a programmable calculator.
Would rely more on programmables to determine slope, conversions, integration, projectile calculations.

Chemistry

I would relate problems more to the use of calculators; scientific notation and trig functions on calculators.
Types of examples of problems would be more difficult -- reflecting the fact that calculators would derive answers faster and easier.
Would put a much stronger emphasis on rapidity of entering numbers for calculations.
I would incorporate calculator literacy on each topic discussed in question 5.
To include other problems more mathematically oriented
We utilize log tables in our book at present but I would probably not use them as much. My overall method would not change.

Biology

I would probably place even more emphasis than at present on quantitative concepts in cp Biology. This is now done in honors and AP Biology.
Would introduce more calculator oriented lab problems in Bio II.
I might emphasize the use of a calculator a bit more in Bio I.
More time could be devoted to population genetics problems to help students to manipulate data more efficiently.
Would simply use actual data.
AP -- I might spend a day or two discussing simple "programs" or key stroke sequences for data analysis.
Calculator use in a first level course is very limited. More math would need to be introduced into course.
I probably would need to give some instruction if calculator use became the standard on the exams.
Would add a section on use of calculator.
Research methods and test and measurement and statistical methods would be stressed.
Would add a section on use of the calculator for various methods.
To comply with addition of more statistical work in course

APPENDIX 1g. Concerns Regarding Calculator Use on Standardized Tests

Physics (Question 11)
- Crib notes/memories:
  - Storing information in programmable memories (19)
  - Students may attach sheets of information to calculators.
  - Some calculators contain information (constants, conversions) that could provide an unfair advantage.
  - Sharing should not be allowed.
- Equity:
  - All students should have the same type. (5)
  - Some students may not be able to afford one. (5)
  - Would they be supplied?
- Relation of calculators to skills tested:
  - Acceptable for science tests, not math tests. (7)
  - Allowing calculators reduces the ability to assess the math involved in science problems. (5)
  - Should be more concerned with concepts than number manupulation. (2)
  - Reactionary not to allow them in physics - still need to know the physics before you use them. (2)
  - Physics exams might become more of a math exercise.
  - Potential for evaluating lower cognitive levels only.
- Other comments:
  - Would have to spend more time on calculator use and less on course content.

Chemistry (Question 11)
- Crib notes/memories:
  - Storing information in programmable memories (20)
  - Built-in information (conversions etc.) could provide an unfair advantage. (4)
  - Students may hide sheets of information in calculator.
  - Sharing should not be allowed.
  - Built-in metric conversions don't work when using conversion factor/label method.
- Equity:
  - All students should have calculators. (2)
  - Students' varied abilities in using calculators causing unfair advantages
- Student dependence/poor use:
  - Math skills are not learned or atrophy. (6)
  - Students may simply manipulate the numbers to match a choice instead of solving the problem.
  - Data entry errors leading to choosing the wrong answer
- Relation of calculators to skills tested:
  - Math skills would no longer be tested on science tests. (2)
  - Simple math should not be a measurement on standardized tests.

* (n) represents the number of times the concern was mentioned, if that was more than once. Related concerns are grouped together.

APPENDIX 1g. (continued)

Biology (Question 11)
- Crib notes/memories:
  - Storing information in programmable memories (10)
  - More sophisticated functions leading to unfair advantages (5)
- Equity:
  - All should have the same type. (3)
  - Some students may not be able to afford one. (5)
  - Acceptable type should be specified.
- Student dependence/poor use:
  - Students are dependent/overuse calculators. (26)
- Relation of calculators to skills tested:
  - Acceptable on science tests, but not math tests. (8)
  - Would no longer be able to assess math skills on science tests. (3)
  - Tests are supposed to measure mental aptitude, not button-pushing.
- Other comments:
  - Favor type I only.
  - Wouldn't approve if it meant more problems or more difficult ones.

Miscellaneous (Question 8)
- Crib notes/memories:
  - Storing information in programmable memories (3)
  - More sophisticated functions leading to unfair advantages. (3)
- Equity:
  - All students should have them. (4)
- Student dependence/poor use:
  - Students are dependent/overuse calculators. (18)
- Relation of calculators to skills tested:
  - Students should know basic skills and shouldn't need calculators on standardized tests. (9)
  - Acceptable on science tests, not math tests. (7)
  - Need to design questions that measure more than button-pushing.
  - Need to test math on science tests.
  - Difficulty and length of test should be increased.

APPENDIX 1h. Responses for Part B: Microcomputers

12. For each course, check boxes to indicate how microcomputers are used in your classes. (Check all boxes that apply.)

	Physics		Chemistry		Biology		Misc.
	Reg	AP	Reg	AP	Reg	AP	
Drill and practice	40	8	60	16	33	11	40
Use of tutorial software	48	18	54	20	45	19	47
Word Processing	32	11	29	16	14	9	17
Simulations of natural phenomena	48	12	28	13	31	15	32
Simulations of laboratory experiments	53	11	47	19	28	24	34
Analysis of laboratory data	40	12	40	19	15	16	22
Recording of laboratory data using interfacing device	26	7	19	12	5	6	12
Use of teacher written programs. If so, what language?	25	6	21	7	8	4	11
Use of student written programs. If so, what language?	17	7	8	6	2	1	5
Communication with information services or data bases	3	0	5	2	1	1	5
Total number giving any response	102	24	87	37	71	37	75
Percent giving any response	66	65	56	60	47	53	47

Programming Languages Used

		Regular courses		AP courses	
		Teacher	Student	Teacher	Student
Physics	Basic	36	19	5	8
	Pascal	3	2	1	1
	Assembler		1		1
	Fortran		1		
Chemistry	Basic	27	10	10	7
	Assembler	1	1	1	1
	Pascal	1			1
Biology	Basic	7	4	2	1
	Pascal	1	1		1
	Pilot	1			
Miscellaneous	Basic	10	4	4	3
	Pascal				1

13. If computers are used in your classes, is any class time devoted to teaching or assisting students in the use of the computer?	Yes	41	7	33	18	29	14	35
	No	64	16	56	14	61	21	51
If yes, how many hours per year? (avg.)		7.8	9.7	8.8	3.9	4.0	3.9	9.0
Number of schools indicating hours.		34	7	25	12	19	8	22

APPENDIX 1h. (continued)

14. Has the course been modified to include topics that are particularly suited to the use of the computer?	Yes	15	4	14	7	15	19	14
	No	97	20	84	27	87	30	84

17. About what percentage of hands-on laboratory experiments have been replaced by computer simulations of laboratory experiments?	zero	89	20	98	37	85	38	83
	1% - 25%	45	6	30	13	33	15	31
	26% - 50%	1	0	1	0	1	1	1
	51% - 75%	0	0	1	0	0	0	0
	76% - 100%	0	0	0	0	0	0	0

18. Are there laboratory or other skills that you feel can be assessed using computer simulations that cannot be assessed using paper and pencil tests?

Physics	Yes	29	No	36	No opinion	71	No response	21
Chemistry	Yes	31	No	42	No opinion	61	No response	20
Biology	Yes	31	No	35	No opinion	66	No response	20
Miscellaneous	Yes	14	No	34	No opinion	42	No response	33

19. For each of the following tests, would you favor that computer administered simulations designed to assess laboratory skills be given in conjunction with the test?

Physics Achievement Test	Yes	35	No	54	No opinion	46	No response	22
AP Physics B Examination	Yes	33	No	34	No opinion	48	No response	42
AP Physics C Examination	Yes	32	No	35	No opinion	48	No response	42
Chemistry Achievement Test	Yes	30	No	59	No opinion	50	No response	15
AP Chemistry Examination	Yes	31	No	49	No opinion	47	No response	27
Biology Achievement Test	Yes	36	No	54	No opinion	45	No response	17
AP Biology Examination	Yes	34	No	47	No opinion	39	No response	32

20. Are you interested in writing multiple-choice test questions for which calculators can be effectively used or that test skills that can best be assessed using a calculator?

Physics	Yes	30	No	105	No response	22
Chemistry	Yes	41	No	93	No response	20
Biology	Yes	22	No	115	No response	15
Miscellaneous	Yes	19	No	77	No response	27

21. Would you like to receive a copy of the questionnaire results?

Physics	Yes	119	No	24	No response	14
Chemistry	Yes	123	No	17	No response	14
Biology	Yes	103	No	33	No response	16
Miscellaneous	Yes	74	No	29	No response	20

APPENDIX 1i. Topics Involving Microcomputer Use

Physics (Question 15)

Regular Courses

Math and General Topics

- Vectors (8)
- Graphing (8)
- Data collection & analysis (8)
- Curve fitting and regression analysis (2)
- Analysis involving calculus-based reasoning
- As a timer (2)
- Statistics

Physics Topics

- Mechanics (12)
- Kinematics (12)
- Projectiles (7)
- Newton's Laws (3)
- Kepler's Laws (3)
- Gravity (3)
- Forces (3)
- Inclined planes
- Simple harmonic motion
- Linear momentum
- Astronomy (4)
- Electricity & Magnetism (7)
- Electronics
- Lenz' Law
- Waves (7)
- Light (3)
- Optics (3)
- Heat & Thermodynamics (5)
- Calorimetry
- Nuclear decay (5)
- Millikan oil drop expt.(3)
- Modern physics
- Molecular activities

AP Courses

Math and General Topics

- Vectors
- Graphing
- Data collection and analysis
- As a timer
- Word processing

Physics Topics

- Mechanics (2)
- Kinematics (2)
- Electricity & Magnetism (2)
- Leads
- Photocells
- Thermistors
- Waves
- Heat
- Astronomy

Chemistry (Question 15)

Regular Courses

Math and General Topics

- Metrics
- Problem solving
- Word problems
- Data acquisition (4)
- Measurements
- Data reduction (5)
- Least squares data analysis
- Percent error
- Graphing (2)
- Lab reports
- Remedial programs

* (n) represents the number of times the topic was mentioned, if that was more than once. Where appropriate, related topics are grouped together.

APPENDIX 1i. (continued)

Chemistry Topics

- Acids/bases (6)
- pH (2)
- pK
- Equilibrium (9)
- LeChatelier's principle (2)
- Equations of state
- Kinetics (5)
- Reaction rates (3)
- Kinetic molecular theory
- Gas laws (22)
- Stoichiometry (14)
- Balancing equations (4)
- Moles (4)
- Chemical formulas (3)
- Chemical composition
- Heat of reaction
- Energetics
- Heat transfer
- Calorimetry
- Ion exchange
- Electromotive series
- Solutions (3)
- Ion concentration
- Solubility
- Redox (2)
- Nuclear topics (2)
- Wave mechanics
- Spectra
- Millikan oil drop expt. (2)
- Titrations (2)
- Periodic table (2)
- Molecular/atomic structure (4)
- Molecular models (2)
- Geometric isomers
- Bonding (3)
- Nomenclature (4)

<u>AP Courses</u>

Math and General Topics

- Metrics
- Data acquisition (2)
- Measurements
- Data reduction (2)
- Least squares data analysis
- Curve fitting
- Reports

Chemistry Topics

- Molecular structure (2)
- Moles (2)
- Stoichiometry (2)
- Chemical composition
- Chemical equations
- Gas laws (6)
- Equation of state
- Equilibrium (2)
- LeChatelier's principle
- Kinetics (2)
- Reaction rates
- Redox
- Acids/bases (4)
- pH
- Raoult's law
- Heat of reaction
- Thermochemistry
- Calorimetry
- Atomic structure (2)
- Nuclear topics
- Titration (3)
- Wave mechanics
- Spectra
- Bonding
- Periodic table (2)
- Millikan oil drop expt.(2)
- VSEPR diagrams

<u>Biology</u> (Question 15)

<u>Regular Courses</u>

Math and General Topics

- Data analysis (2)
- Graphing
- Review (2)

APPENDIX 1i. (continued)

Biology Topics

- Populations (3)
- Genetics (26)
- Protein synthesis (2)
- DNA replication
- Evolution (3)
- Ecology (9)
- Chemistry
- Biochemistry (4)
- Nucleic acid structure
- Diffusion (2)
- Enzymology
- Reaction time
- Osmosis
- Cells (8)
- Meiosis (2)
- Mitosos (2)
- Microscope
- Microbiology
- Cytology
- Physiology (5)
- Photosynthesis (5)
- Respiration (4)
- Metabolism
- Heart & pulse rates
- Skin temperature
- Reproduction
- Classification (4)
- Dissection (2)
- Anatomy (2)
- Taxonomy (2)
- Senses
- Botany
- JIS series

<u>AP Courses</u>

Math and General Topics

- Data analysis (2)
- Graphing
- Review
- Statistics

Biology Topics

- Biochemistry (3)
- Enzymology (3)
- Cells (2)
- Cytology
- Metabolism (3)
- Respiration (3)
- Physiology (2)
- Circulation
- Fermentation
- Photosynthesis
- Genetics (10)
- Populations(2)
- Evolution
- Ecology (5)
- Anatomy (3)
- Taxonomy (2)
- Classification (2)
- Dissection

<u>Miscellaneous</u> (Question 12)

Math and General Topics

- Graphing (5)
- Data analysis
- Metrics (4)
- Scientific method
- Significant figures
- Hypotheses
- Problem solving
- Conversions
- Lab Reports (3)
- Tutorials

APPENDIX 1i. (continued)

Science Topics

- Physics
- Motion (4)
- Mechanics
- Pendulum
- Orbits
- Machines (2)
- Energy
- Electricity
- Heat
- Optics
- Light
- Sound
- Atomic structure (2)
- Density (3)
- Chemistry (3)
- Periodic table (2)
- Chemical symbols
- Gas laws
- Boiling & freezing points
- Anatomy (2)
- Population studies
- Earthquakes (5)
- Plate tectonics/ crust movement (4)
- Minerology (2)
- Erosion
- Geologic time
- Petrology
- Mineral identification
- Earthquakes
- Water cycle
- Water budget
- Meteorology/weather (8)
- Cloud formation
- Astronomy (6)
- Sky charts
- Phases
- Distances

APPENDIX 1j. Available Computer Models

Computer models available (Question 16 [13 for Miscellaneous])

		Physics		Chemistry		Biology		Misc
Make	Model	Reg	AP	Reg	AP	Reg	AP	
Apple	unspecified	17	2	22	6	21	3	15
	MacIntosh	2	1					
	I					1		
	II	15	2	14	4	12	7	17
	II+	9	1	5	2	6	1	5
	IIc	6	2	9	2	5	1	5
	IIe	75	18	59	25	52	19	57
IBM	unspecified	6	2	5		10	4	9
	PC	10	5	6	4	3	1	3
	PC jr	1		1		2		1
	XT					1		
	AT					1		1
Commodore	unspecified	5	1	6	1	3		1
	64	9	1	3		1		1
	PET	4		1		1		
	8000 series	1						
	9000 series	1						
Radio Shack	unspecified	8	1	6	1	4	1	3
	TRS 80 color	1		1	1			1
	TRS 80 I	14	3	13	4	11	5	14
	TRS 80 II	1		2				
	TRS 80 III	4		2		1		
	TRS 80 IV	3				2		
	Tandy	1						2
	Tandy 1000	2		1		1		
Franklin	unspecified	3		2	1	3	1	2
	1200	1						
DEC	PDP 11/24	1	1					
Hewlett-Packard	86B	1	1					
Atari	unspecified	2		2	1	2		3
	800			1	1			
	800 XL					1		
Texas Inst.	unspecified			1				
	99	1						
Weber	unspecified	1						
NCR	unspecified	1		1				
Digital	unspecified			1				
	VT 180			1	1	1		
Apricot	unspecified							1
Leading Edge	unspecified							1
Acorn	unspecified			1				

APPENDIX 1k. Skills Assessed via Computers and Related Comments

Physics (Question 18)
Skills (and comments related to them)

- Can focus on conclusions due to easier data analysis. (2)
- Writing good lab reports
- Reading of a vernier
- Calibration of instruments
- Test "what if" reasoning and analysis
- Provide in-depth standardized exercise, can uncover deficiencies not apparent in normal lab
- Simulation closer to lab than paper and pencil
- Manipulation of equipment, lab technique, working with others can't be assessed.

Topics and other considerations

- Mechanics (projectiles, orbits, waves etc.) (5)
- Circuits - math relationships
- Nuclear interactions (Rutherford scattering etc.)
- Statistical modeling
- Replace expensive lab materials (3)
- Analysis of data easier (3)
- More effective in showing effect of changing parameters (2)
- Experiments too difficult to do in lab
- Quicker graphing

Chemistry (Question 18)
Skills (and comments related to them)

- Lab skills could be assessed better (3)
- Changing parameters and their effects (3)
- Interpretation of infrared and NMR spectra
- Scale reading
- Use of equipment
- Allow for branched decision-making
- Reasoning through physical relationships through simulation with Math applications
- Abstract ideas that are hard to visualize
- Many skills could be tested more quickly.
- Would not want poor computer skills to disadvantage students.

Topics and other considerations

- Titration (3)
- Rate of reactions (2)
- Simulation of atomic structure
- Temperature curves
- Equilibrium
- Three-dimensional concepts
- Three-dimensional crystal/molecule
- Difficult Math solutions (cubic equations etc.)
- Dangerous labs(4)
- Expensive labs (3)
- Difficult labs (2)
- Animated lab situations
- Immediate feedback might provide better understanding.

* (n) represents the number of times the skill or topic was mentioned, if that was more than once. Related comments are grouped together where appropriate.

Biology (Question 18)
Skills (and comments related to them)
- Evaluation of biological systems
- Depth perception of microscopic skills

Topics and other considerations
- Ecology/environmental problems (5)
- Genetic model populations (2)
- Large populations (2)
- Population density changes
- Species interactions
- Long-range growth studies
- Cancer projections
- Concepts like classification
- Basic biochemistry
- Chemical bonding becomes more concrete.
- DNA structure and replication becomes more understandable.
- Data analysis (5)
- Graphing
- Costly labs
- Dangerous labs

Miscellaneous (Question 15)
Skills (and comments related to them)
- Students' speed of recall
- Students share information in lab. Using a simulation would more accurately assess the student's progress.
- Allows time for testing other skills due to time saved in accessing and processing information, data, etc.
- Provides more opportunity to creatively develop students' problem-solving skills.
- Students need the hands-on experience that simulations do not provide. (3)
- Most students do not have the computer skills to make computer time a valuable tool in the classroom.
- Blackboard or textbook illustrations serve just as well.

Topics and other considerations
- Acceleration
- Kinetic energy
- Orbits and Kepler's laws
- Earthquakes
- Calculating circumference of the Earth
- Energy exchange
- Weather analysis
- Three-dimensional situations
- Many simulations are cheaper than buying the equipment for certain experiments.
- Much statistical and analytical data is much better assimilated and processed by computer.
- Students in chemistry classes could use them to see if their lab calculations are correct.

APPENDIX 2a. Cover Letter

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

609 921-9000
CABLE EDUCTESTSVC
•
COLLEGE BOARD PROGRAMS
•
TEST DEVELOPMENT

Dear Physics Department Chairperson:

We need your help. The rapid increase in use of electronic calculators and microcomputers by students and the general population has posed serious questions for those who develop standardized tests. Has the physics curriculum been changed by these devices? Should the use of calculators be allowed on standardized tests? The College Board's Sciences Advisory Committee needs responses to these and other pertinent questions from you and your staff.

At the present time, calculators and other devices are not permitted in the testing room during the administration of College Board science and mathematics tests of the Admissions Testing Program. Calculators are allowed with the Advanced Placement Chemistry and Physics Examinations, but calculator memories must be cleared of both programs and data and no peripheral devices such as magnetic cards or tapes are permitted.

Periodically the Science Advisory Committee evaluates its position on such important issues. It will be discussing this issue and making recommendations to the College Board soon. In order to arrive at an informed and reasonable policy concerning the use of calculators in the future, it is important that the enclosed questionnaires be completed and returned. Two questionnaires are enclosed. Please route the questionnaires to the staff teaching introductory courses for completion and then return both questionnaires in the envelope provided. We may wish to list, in a report of the results, the names of the institutions that participate in this survey, but we will not publish any results by individual institution.

We hope you will agree to participate in this survey. In turn, we will be happy to share the results with you. Thank you for your time and effort in this endeavor.

Sincerely,

Naomi Martin

Naomi Martin
Chairperson, College Board Sciences Advisory Committee and Science Coordinator,
Horry County Public Schools, SC

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

800-021-0000
CABLE-EDUCTESTSVC
•
COLLEGE BOARD PROGRAMS
•
TEST DEVELOPMENT

Dear Chemistry Department Chairperson:

We need your help. The rapid increase in use of electronic calculators and microcomputers by students and the general population has posed serious questions for those who develop standardized tests. Has the chemistry curriculum been changed by these devices? Should the use of calculators be allowed on standardized tests? The College Board's Sciences Advisory Committee needs responses to these and other pertinent questions from you and your staff.

At the present time, calculators and other devices are not permitted in the testing room during the administration of College Board science and mathematics tests of the Admissions Testing Program. Calculators are allowed with the Advanced Placement Chemistry and Physics Examinations, but calculator memories must be cleared of both programs and data and no peripheral devices such as magnetic cards or tapes are permitted.

Periodically the Science Advisory Committee evaluates its position on such important issues. It will be discussing this issue and making recommendations to the College Board soon. In order to arrive at an informed and reasonable policy concerning the use of calculators in the future, it is important that the enclosed questionnaires be completed and returned. Two questionnaires are enclosed. Please route the questionnaires to the staff teaching introductory courses for completion and then return both questionnaires in the envelope provided. We may wish to list, in a report of the results, the names of the institutions that participate in this survey, but we will not publish any results by individual institution.

We hope you will agree to participate in this survey. In turn, we will be happy to share the results with you. Thank you for your time and effort in this endeavor.

Sincerely,

Naomi Martin

Naomi Martin
Chairperson, College Board Sciences Advisory Committee and Science Coordinator,
Horry County Public Schools, SC

70a

EDUCATIONAL TESTING SERVICE PRINCETON, N.J. 08541

800 921-9000
CABLE EDUCTESTSVC
•
COLLEGE BOARD PROGRAMS
•
TEST DEVELOPMENT

Dear Biology Department Chairperson:

We need your help. The rapid increase in use of electronic calculators and microcomputers by students and the general population has posed serious questions for those who develop standardized tests. Has the biology curriculum been changed by these devices? Should the use of calculators be allowed on standardized tests? The College Board's Sciences Advisory Committee needs responses to these and other pertinent questions from you and your staff.

At the present time, calculators and other devices are not permitted in the testing room during the administration of College Board science and mathematics tests of the Admissions Testing Program. Calculators are allowed with the Advanced Placement Chemistry and Physics Examinations, but calculator memories must be cleared of both programs and data and no peripheral devices such as magnetic cards or tapes are permitted.

Periodically the Science Advisory Committee evaluates its position on such important issues. It will be discussing this issue and making recommendations to the College Board soon. In order to arrive at an informed and reasonable policy concerning the use of calculators in the future, it is important that the enclosed questionnaires be completed and returned. Two questionnaires are enclosed. Please route the questionnaires to the staff teaching introductory courses for completion and then return both questionnaires in the envelope provided. We may wish to list, in a report of the results, the names of the institutions that participate in this survey, but we will not publish any results by individual institution.

We hope you will agree to participate in this survey. In turn, we will be happy to share the results with you. Thank you for your time and effort in this endeavor.

Sincerely,

Naomi Martin

Naomi Martin
Chairperson, College Board Sciences Advisory Committee and Science Coordinator,
Horry County Public Schools, SC

APPENDIX 2b. Hand Calculator and Microcomputer Surveys

HAND CALCULATOR AND MICROCOMPUTER SURVEY

PHYSICS COURSES

1987

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and microcomputer use in introductory college science courses. The Committee also needs to solicit the opinions of college teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the institutions that participate in the survey but we will not publish any results by individual institutions. The report will be distributed to all respondents who request it.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. If there is a separate instructor for the lab associated with the course you teach, please forward this questionnaire to that person after you have completed those portions pertaining to the lecture component of the course. Please return the questionnaire, when completed, to your department chairperson, who will return the survey to Educational Testing Service. Thank you.

APPENDIX 2b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I.	Simple	Arithmetic functions only. Usually cost less than $10.
II.	Scientific	Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III.	Programmable	Usually cost more than $20.

For each introductory physics course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)	Non-calculus survey course sequence for non-physics majors			Calculus-based sequence for physics majors and/or engineers		
1. Hand calculators are	Calculator Type I	II	III	Calculator Type I	II	III
NOT necessary for problem-solving						
necessary for use in doing some homework						
necessary for use in doing some laboratory work						
NOT permitted on any tests						
permitted during some but not all tests						
permitted or required during ALL tests						

2. Is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percent of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

APPENDIX 2b. (continued)

4. If you teach special techniques for which calculator use is necessary, please list these techniques below.

Non-calculus course sequence	Calculus-based course sequence
Topics _____	Topics _____
_____	_____
_____	_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

5. Do you think that your students make intelligent use of the calculator?

Yes _____ No _____ No opinion _____

Please comment _____

_____

6. Do you think students should be permitted to use calculators on the following College Board tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Physics Achievement Test						
AP Physics Examinations						

7. Do you have any concerns about the use of calculators on standardized tests in general?

Yes _____ No _____

Please explain your concerns. _____

_____

_____

_____

APPENDIX 2b. (continued)

Part B: Microcomputers

8. For each introductory physics course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)

	Non-calculus survey course sequence for non-physics majors	Calculus-based sequence for physics majors and/or engineers
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher-written programs. If so, what language?	. . . . .	. . . . .
Use of student-written programs. If so, what language?	. . . . .	. . . . .
Communication with information services or data bases.		

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?

Yes		
No		
If yes, about how many hours for the entire course sequence?		

10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?

Yes		
No		

11. Please indicate the topics in each course that are particularly suited suited to the use of the microcomputer.

12. What microcomputer makes and models are available at your school for student use?

13. About what percent of hands-on laboratory experiments have been replaced by micro-computer simulations of laboratory experiments?

	Non-calculus survey course sequence for non-physics majors	Calculus-based sequence for physics majors and/or engineers
zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

14. Are there laboratory or other skills that you feel can be assessed using micro-computer simulations that cannot be assessed using paper and pencil tests?

Yes ____ No ____ No opinion ____

Please explain. _____

_____

_____

_____

15. For each of the following tests, would you favor that micro-computer administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Physics Achievement Test Yes ___ No ___ No opinion ___
AP Physics B Examination Yes ___ No ___ No opinion ___
AP Physics C Examination Yes ___ No ___ No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes.

16. Is a mainframe computer used in your course sequence?

	Non-calculus course sequence	Calculus-based sequence
Yes		
No		

17. About what percent of computer use in your course sequence involves the mainframe computer?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

APPENDIX 2b. (continued)

18. Are you interested in writing multiple-choice test questions for either the Physics Achievement Test or AP Physics Examinations?

Yes ___ No ___

19. Would you like to receive a copy of the questionnaire results?

Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ College Code # /_/_/_/_/_/

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by April 30, 1987 to:

Will Pfeiffenberger, 07-E Educational Testing Service, Princeton, NJ 08541

APPENDIX 2b. (continued)

HAND CALCULATOR AND MICROCOMPUTER SURVEY

CHEMISTRY COURSES

1987

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and microcomputer use in introductory college science courses. The Committee also needs to solicit the opinions of college teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the institutions that participate in the survey but we will not publish any results by individual institutions. The report will be distributed to all respondents who request it.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. If there is a separate instructor for the lab associated with the course you teach, please forward this questionnaire to that person after you have completed those portions pertaining to the lecture component of the course. Please return the questionnaire, when completed, to your department chairperson, who will return the survey to Educational Testing Service. Thank you.

APPENDIX 2b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I.	Simple	Arithmetic functions only. Usually cost less than $10.
II.	Scientific	Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III.	Programmable	Usually cost more than $20.

For each introductory chemistry course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)	Course sequence for non-chemistry majors			Course sequence for chemistry majors		
1. Hand calculators are	Calculator Type I	II	III	Calculator Type I	II	III
NOT necessary for problem-solving						
necessary for use in doing some homework						
necessary for use in doing some laboratory work						
NOT permitted on any tests						
permitted during some but not all tests						
permitted or required during ALL tests						

2. Is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percent of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. Please list below any topics for which calculator use is necessary.

Course sequence for non-chemistry majors

Topics _____

_____

_____

Course sequence for chemistry majors

Topics _____

_____

_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

5. Do you think that your students make intelligent use of the calculator?

Yes _____ No _____ No opinion _____

Please comment _____

_____

6. Do you think students should be permitted to use calculators on the following College Board tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Chemistry Achievement Test						
AP Chemistry Examinations						

7. Do you have any concerns about the use of calculators on standardized tests in general?

Yes _____ No _____

Please explain your concerns. _____

_____

_____

_____

APPENDIX 2b. (continued)

Part B: Microcomputers

8. For each introductory chemistry course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)	Course sequence for non-chemistry majors	Course sequence for chemistry majors
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher-written programs. If so, what language?	. . . . .	. . . . .
Use of student-written programs. If so, what language?	. . . . .	. . . . .
Communication with information services or data bases.		

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?

Yes		
No		
If yes, about how many hours for the entire course sequence?		

10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?

Yes		
No		

11. Please indicate the topics in each course that are particularly suited to the use of the microcomputer.

12. What microcomputer makes and models are available at your school for student use?

13. About what percent of hands-on laboratory experiments have been replaced by micro-computer simulations of laboratory experiments?

	Course sequence for non-chemistry majors	Course sequence for chemistry majors
zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

14. Are there laboratory or other skills that you feel can be assessed using micro-computer simulations that cannot be assessed using paper and pencil tests?

Yes ____ No ____ No opinion ____

Please explain. _____

_____

_____

_____

15. For each of the following tests, would you favor that micro-computer administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Chemistry Achievement Test Yes ___ No ___ No opinion ___
AP Chemistry Examination Yes ___ No ___ No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes.

16. Is a mainframe computer used in your course sequence?

	Course sequence for non-chemistry majors	Course sequence for chemistry majors
Yes		
No		

17. About what percent of computer use in your course sequence involves the mainframe computer?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

APPENDIX 2b. (continued)

18. Are you interested in writing multiple-choice test questions for either the Chemistry Achievement Test or AP Chemistry Examinations?

Yes ___ No ___

19. Would you like to receive a copy of the questionnaire results?

Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ College Code # /_/_/_/_/_/

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by April 30, 1987 to:

Will Pfeiffenberger, 07-E Educational Testing Service, Princeton, NJ 08541

HAND CALCULATOR AND MICROCOMPUTER SURVEY

BIOLOGY COURSES

1987

The purpose of this survey, commissioned by the College Board's Science Advisory Committee, is to determine the extent and nature of calculator and microcomputer use in introductory college science courses. The Committee also needs to solicit the opinions of college teachers on related matters such as the use of calculators on standardized tests.

Please answer all questions. Your responses will remain confidential. A report of the results will probably list the names of the institutions that participate in the survey but we will not publish any results by individual institutions. The report will be distributed to all respondents who request it.

There are two parts to this questionnaire. The first deals with calculator use; the second with microcomputer use. If there is a separate instructor for the lab associated with the course you teach, please forward this questionnaire to that person after you have completed those portions pertaining to the lecture component of the course. Please return the questionnaire, when completed, to your department chairperson, who will return the survey to Educational Testing Service. Thank you.

APPENDIX 2b. (continued)

Part A: Hand Calculators

For the purposes of this survey, calculators are divided into three types:

I.	Simple	Arithmetic functions only. Usually cost less than $10.
II.	Scientific	Includes trigonometric and exponential functions. Usually cost between $10 and $20.
III.	Programmable	Usually cost more than $20.

For each introductory biology course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)

1. Hand calculators are

	Course sequence for non-biology majors			Course sequence for biology majors (for combined sequence for majors and non-majors)		
	Calculator Type			Calculator Type		
	I	II	III	I	II	III
NOT necessary for problem-solving						
necessary for use in doing some homework						
necessary for use in doing some laboratory work						
NOT permitted on any tests						
permitted during some but not all tests						
permitted or required during ALL tests						

2. Is any class time devoted to teaching or assisting students in the use of the calculator?

Yes						
No						

3. About what percent of your students use each type of calculator?

less than 25%						
25% - 49%						
50% - 79%						
80% - 99%						
100%						

4. Please list below any topics you teach for which calculator use is necessary.

Course sequence for non-biology majors

Topics _____

_____

_____

Course sequence for biology majors

Topics _____

_____

_____

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

_____

_____

_____

5. Do you think that your students make intelligent use of the calculator?

Yes _____ No _____ No opinion _____

Please comment _____

_____

6. Do you think students should be permitted to use calculators on the following College Board tests?

	Type of Calculator					
	Type I		Type II		Type III	
	Yes	No	Yes	No	Yes	No
SAT Mathematics Sections						
Biology Achievement Test						
AP Biology Examination						

7. Do you have any concerns about the use of calculators on standardized tests in general?

Yes _____ No _____

Please explain your concerns. _____

_____

_____

_____

APPENDIX 2b. (continued)

Part B: Microcomputers

8. For each introductory biology course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)	Course sequence for non-biology majors	Course sequence for biology majors (or combined sequence)
Drill and practice		
Use of tutorial software		
Word Processing		
Simulations of natural phenomena		
Simulations of laboratory experiments		
Analysis of laboratory data		
Recording of laboratory data using interfacing device		
Use of teacher-written programs. If so, what language?	- - - - - - - - -	- - - - - - - - -
Use of student-written programs. If so, what language?	- - - - - - - - -	- - - - - - - - -
Communication with information services or data bases.		

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?

Yes		
No		
If yes, about how many hours for the entire course sequence?		

10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?

Yes		
No		

11. Please indicate the topics in each course that are particularly suited to the use of the microcomputer.

12. What microcomputer makes and models are available at your school for student use?

13. About what percent of hands-on laboratory experiments have been replaced by micro-computer simulations of laboratory experiments?

	Course sequence for non-biology majors	Course sequence for biology majors (or combined sequence)
zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

14. Are there laboratory or other skills that you feel can be assessed using micro- computer simulations that cannot be assessed using paper and pencil tests?

Yes ____ No ____ No opinion ____

Please explain. _____

_____

_____

_____

15. For each of the following tests, would you favor that microcomputer administered simulations designed to assess laboratory skills be given in conjunction with the normal test?

Biology Achievement Test Yes ___ No ___ No opinion ___
AP Biology Examination Yes ___ No ___ No opinion ___

(Optional) Please attach examples of calculator or microcomputer materials you are using with your classes.

16. Is a mainframe computer used in your course sequence?

	Course sequence for non-biology majors	Course sequence for biology majors (or combined sequence)
Yes		
No		

17. About what percent of computer use in your course sequence involves the mainframe computer?

zero		
1% - 25%		
26% - 50%		
51% - 75%		
76% - 100%		

18. Are you interested in writing multiple-choice test questions for either the Biology Achievement Test or AP Biology Examination?

Yes ___ No ___

19. Would you like to receive a copy of the questionnaire results?

Yes ___ No ___

Questionnaire completed by _____
(Optional) Signature

_____
(Optional) Name (please print)

Title _____

Institution _____ College Code # /_/_/_/_/_/

Address _____

City, State, Zip _____

Please RETURN THIS QUESTIONNAIRE by April 30, 1987 to:

Will Pfeiffenberger, 07-E Educational Testing Service, Princeton, NJ 08541

APPENDIX 2c. FOLLOW-UP POSTCARD

Last month a survey on calculator and computer use in college science courses was mailed to your department, but so far no response has been received from your institution. The survey was sponsored by the College Board Sciences Advisory Committee and the questionnaire included questions on the use of calculators on national standardized tests. The experiences and opinions of all the faculty at the colleges in the sample are valued, so the deadline for returning questionnaires has been extended to May 15. If you no longer have the questionnaires and still wish to respond to the survey, you may call collect to Mr. Will Pfeiffenberger (609) 734-1466 to receive additional questionnaires. Thank you for your attention.

APPENDIX 2d. Responses for Part A: Hand Calculators

Physics

	Users requiring Achievement Tests	Large users	Total
Number of surveys returned	111	170	281
Number responding for non-majors' courses	78	135	213
Number responding for majors course	90	141	231

For each introductory physics course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)	Non-calculus survey course sequence for non-physics majors			Calculus-based sequence for physics majors and/or engineers		
1. Hand calculators are	Calculator Type I	II	III	Calculator Type I	II	III
NOT necessary for problem-solving	7/14	10/12	36/44	2/13	7/14	35/49
necessary for use in doing some homework	17/34	61/97	2/5	15/22	78/117	1/9
necessary for use in doing some laboratory work	13/34	62/100	2/8	14/22	78/115	5/13
NOT permitted on any tests	0/2	0/0	7/5	3/1	3/1	10/5
permitted during some but not all tests	5/5	6/5	5/3	5/4	7/7	7/4
permitted or required during ALL tests	26/59	63/117	21/47	27/61	76/130	25/57
2. Is any class time devoted to teaching or assisting students in the use of the calculator? Yes	1/3	12/20	0/4	1/1	10/15	3/5
No	52/61	60/93	48/74	59/87	78/109	59/84
3. About what percent of your students use each type of calculator? less than 25%	27/36	1/3	29/43	24/39	1/4	36/47
25% - 49%	3/6	3/16	1/8	2/3	5/13	7/18
50% - 79%	2/7	12/19	1/4	1/0	14/36	5/12
80% - 99%	3/5	33/45	2/3	1/4	40/44	2/7
100%	3/3	17/29	3/0	3/3	22/21	3/5

* When numbers are reported as n/n, the first number refers to users requiring Achievement Test scores, the second to large users of Achievement Tests.

APPENDIX 2d. (continued)

Chemistry

	Users requiring Achievement Tests	Large users	Total
Number of surveys returned	115	202	317
Number responding for non-majors' courses	87	165	252
Number responding for majors' courses	100	173	273

For each introductory chemistry course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)

1. Hand calculators are	Course sequence for non-chemistry majors — Calculator Type I	II	III	Course sequence for chemistry majors — Calculator Type I	II	III
NOT necessary for problem-solving	8/20	13/33	34/76	4/11	6/10	36/73
necessary for use in doing some homework	24/57	60/103	4/1	25/56	81/144	6/4
necessary for use in doing some laboratory work	25/55	60/96	5/1	28/56	75/136	6/5
NOT permitted on any tests	0/2	0/2	11/22	0/0	0/0	10/20
permitted during some but not all tests	0/3	1/7	2/0	0/4	1/6	3/2
permitted or required during ALL tests	36/90	78/136	24/52	42/88	95/165	33/58

2. Is any class time devoted to teaching or assisting students in the use of the calculator?							
Yes	4/10	18/38	1/1	3/7	19/53	3/2
No	47/98	59/105	39/83	53/96	77/108	46/85

3. About what percent of your students use each type of calculator?						
less than 25%	23/63	3/12	38/72	30/68	0/1	42/75
25% - 49%	7/13	7/17	4/9	6/15	7/14	3/19
50% - 79%	3/13	22/35	2/1	3/3	23/46	6/4
80% - 99%	4/13	22/55	2/0	1/5	37/63	3/1
100%	6/8	23/24	2/0	8/1	28/38	3/2

Biology

	Users requiring Achievement Tests	Large users	Total
Number of surveys returned	64	130	194
Number responding for non-majors' courses	41	93	134
Number responding for majors' courses	60	114	174

For each introductory biology course sequence (2 semesters, 3 quarters, or equivalent) that you teach, check the boxes that describe the use of each type of hand calculator. (Check all that apply.)	Course sequence for non-biology majors			Course sequence for biology majors (or combined sequence for majors and non-majors)		
1. Hand calculators are	Calculator Type I	II	III	Calculator Type I	II	III
NOT necessary for problem-solving	25/52	26/50	29/53	29/42	33/50	40/60
necessary for use in doing some homework	9/24	4/8	3/3	16/40	14/31	4/5
necessary for use in doing some laboratory work	8/26	4/12	3/0	24/42	15/39	4/1
NOT permitted on any tests	10/9	10/10	10/10	11/13	12/14	13/14
permitted during some but not all tests	4/7	3/3	3/0	6/9	4/11	3/3
permitted or required during ALL tests	12/35	10/25	8/14	24/54	21/46	16/27
2. Is any class time devoted to teaching or assisting students in the use of the calculator? Yes	2/0	1/4	0/0	0/3	1/8	0/1
No	35/84	28/64	28/62	50/92	46/81	42/74
3. About what percent of your students use each type of calculator? less than 25%	18/36	17/27	21/33	18/35	14/23	23/38
25% - 49%	6/17	3/10	0/2	11/18	11/18	4/5
50% - 79%	3/7	1/9	0/0	4/12	6/13	1/3
80% - 99%	1/5	2/6	1/1	5/12	6/19	3/2
100%	0/2	1/1	0/0	2/6	2/3	1/1

4. Please list below any topics you teach for which calculator use is necessary.

	Response for course sequence for non-majors	Response for course sequence for majors
Physics	21	24
Chemistry	170	212
Biology	49	113

Please list below any textbooks or other instructional materials that you have found useful in teaching the topics listed above.

The number of responses were as follows:
Physics 4, Chemistry about 130, and Biology about 40.
(Topics and texts are listed in Appendix XII.)

5. Do you think that your students make intelligent use of the calculator?

Physics	Yes 65/108	No 25/34	No opinion 14/16
Chemistry	Yes 77/125	No 16/49	No opinion 12/13
Biology	Yes 27/65	No 10/19	No opinion 18/38

6. Do you think students should be permitted to use calculators on the following College Board tests? (Numbers quoted here are percents of the total number of questionnaires returned for each group. B indicates blank, i.e. no response.)

	Type of Calculator								
	Type I			Type II			Type III		
PHYSICS	Yes	No	B	Yes	No	B	Yes	No	B
SAT Mathematics Sections	22/28	35/35	43/36	39/43	42/38	20/18	8/16	53/46	39/36
Physics Achievement Test	35/48	19/16	46/36	77/78	19/14	5/8	14/19	49/44	37/36
AP Physics Examinations	35/48	19/14	46/38	78/81	18/11	5/8	15/21	49/41	36/38
CHEMISTRY									
SAT Mathematics Sections	34/32	22/27	45/40	55/49	26/32	20/19	10/12	44/48	47/40
Chemistry Achievement Test	54/54	5/4	43/41	88/86	3/7	10/7	17/19	42/43	43/37
AP Chemistry Examination	53/54	3/3	45/41	88/87	3/6	10/7	17/19	40/43	44/38
BIOLOGY									
SAT Mathematics Sections	47/48	38/32	14/20	44/51	39/33	16/17	13/19	59/51	27/30
Biology Achievement Test	52/62	34/24	13/15	45/60	36/26	17/15	19/26	48/48	31/25
AP Biology Examination	52/59	36/25	11/16	45/60	39/26	14/15	20/25	52/49	27/26

APPENDIX 2d. (continued)

7. Do you have any concerns about the use of calculators on standardized tests in general?

Physics	Yes 42/65	No 68/99
Chemistry	Yes 38/56	No 75/141
Biology	Yes 22/52	No 36/74

APPENDIX 2e. Topics Involving Calculator Use and Related Texts

Physics

Non-calculus courses

Math and General Topics

- Trig functions (7)
- log & ln (7)
- Exponentials (5)
- x^y
- $\sqrt{a^2 + b^2}$
- $\sqrt{x}$ and/or x^2 (2)
- Inverse function
- Polar-rectangular coordinates
- Error analysis
- Round-off error problems
- Mean/standard deviation (2)
- Statistics
- Data analysis (2)
- Least squares fit
- Linear regression
- Vectors (2)

Physics Topics

- spectroscopic parallax
- RLC circuits

Calculus based courses

Math and General Topics

- Basic scientific functions
- log & ln (2)
- Exponentials
- x^y (2)
- $\sqrt{a^2 + b^2}$
- Trig functions (3)
- Hyperbolic functions
- Polar-rectangular coordinates
- Average and/or standard deviation (5)
- Statistics
- Error analysis
- Linear regression (4)
- Linear least squares (4)
- Data analysis (2)
- Series expansions
- Iterative techniques (2)
- Approximation methods
- Vectors

Physics Topics

- Mechanics (3)
- Waves
- Electricity & Magnetism
- Electricity
- Electricity time constants
- Dipole equipotential surfaces
- Thermodynamics
- Modern
- Absorption coefficients
- Nucleon half-life

Texts and Other Materials

Bennett, Scientific & engineering problems - Solving with the Computer
Eisbert & Lerner, Physics & Applications, I & II; McGraw-Hill
Sears, Zemansky & Young, College Physics
Sears, Zemansky & Young, University Physics
Calculator Instruction Book

* (n) represents the number of times the topic or text was mentioned, if that was more than once. Related topics are grouped together, and listed in decreasing order of frequency.

Chemistry

Courses for non-majors

Math and General Topics

- All Math work (19)
- Conversions (9)
- Metrics (4)
- Scientific notation (3)
- S. I. units
- log & ln (7)
- exponents (3)
- $\sqrt{x}$ etc.
- Data analysis (4)
- Slopes of lines
- Dimensional analysis (2)
- Measurements
- Problem-solving
- Cost analysis

Chemistry Topics

- Stoichiometry (91)
- Moles (5)
- Molarity (2)
- Percent composition (2)
- Molecular weight
- Gases/gas laws (47)
- Vapor pressure
- Equilibrium (70)
- K_A (3)
- K_{sp} (3)
- K_B
- K_{eq}
- Kinetics (53)
- Reaction rates
- Electrochemistry (18)
- Nernst equation (2)
- Electron energies
- Redox
- pH (55)
- Acids/bases (13)
- Buffers (2)
- Colligative properties
- Thermodynamics (35)
- Thermochemistry (9)
- Calorimetry (3)
- Energy
- Nuclear (10)
- Quantum (2)
- Mass differences
- Solutions (18)
- Concentrations (4)
- Solubility
- Titration (3)
- Solid structure
- Solid state
- Liquids and solids
- States of matter
- Density (3)
- Chemistry & environment
- Radiochemistry
- Spectroscopy
- Electromagnetic radiation
- Atomic/molecular structure (3)

Courses for Chemistry majors

Math and general topics

- All math (28)
- log & ln (10)
- Exponentials/exponents (6)
- $\sqrt{x}$ & higher roots (3)
- Conversions (2)
- S. I. units
- Scientific notation
- Statistics (2)
- Iterative calculations (2)
- Data analysis (3)
- Linear regression
- Dimensional analysis
- Metrics
- Measurements
- Problem solving
- Remedial work

APPENDIX 2e. (continued)

Chemistry Topics

- Stoichiometry (104)
- Moles (5)
- Molarity
- Percent composition
- Empirical formulae
- Gases/gas laws (52)
- Vapor pressure (3)
- Graham's Law
- Equilibrium (129)
- K_{sp} (8)
- K_A (3)
- K_B (3)
- Ionic equilibrium
- Kinetics (106)
- Reaction rates (6)
- Electrochemistry (41)
- Nernst equation (6)
- Potentials (2)
- Activation energy
- emf
- Electron energy
- Redox (6)
- pH (69)
- Acid/base (24)
- Buffers (5)
- pK (2)
- Colligative properties (3)
- Thermodynamics (65)
- Thermochemistry (11)
- Calorimetry (3)
- Heat exchange
- $\Delta p(k)/\Delta T$
- Energy (3)
- Nuclear (decay/radiation) (10)
- Quantum (6)
- Solutions (14)
- Solubility (4)
- Concentrations (3)
- Titrations (6)
- Properties of matter
- States of matter
- Solid structure
- Solid state
- Liquids and solids
- Spectroscopy (2)
- Physical chemistry topics
- Physical chemistry lab
- Density
- Radiochemistry (3)
- Electromagnetic radiation
- Atomic/molecular structure (10)
- Bohr equation

Texts and Other Materials

Standard/Most/Any chemistry text (35)
Own handouts (2)
Boikess & Sorum, 7th ed.
Boikess, Chemical Principles
Brady & Holrum text, supplemented by Zumdahl problem manual
Brady & Holum, Fundamentals of Chemistry (4) (Appendix material (1))
Brady & Humiston, General Chemistry (3) (study guide (1))
Brown & LeMay, Chemistry; The Central Science (2)
Brown & LeMay, General Chemistry
J. N. Butler, Ionic Equilibrium; Addison-Wesley
Butler & Grosser
Castellan, Physical Chemistry
Chang, Chemistry
Chang, General Chemistry
Davis, Gailey, and Whitten, Principles of Chemistry
Dickerson, Gray, Darensbourg, Chemical Principles (3)
Ebbing
Ebbing, Chemistry
Darrell Ebbing, General Chemistry (5)
Gillespie, et al., Chemistry; Allyn & Bacon
Dorothy Goldish, Basic Mathematics for Beginning Chemistry (2)
Herron, Understanding Chemistry (3)

APPENDIX 2e. (continued)

Herzog, Exams and Solutions
John Hill, Chemistry for Changing Times
Holtzclaw
Holtzclaw, Robinson, Nebergall, General Chemistry
Holtzclaw, Robinson, & Nebergall, College Chemistry
Holum (2)
John Holum, Fundamentals of General, Organic & Biological Chemistry
Johnson, Numerical Methods in Chemistry
Katz & Purcell, General Chemistry
King, Chemistry
Kroschwitz & Winokur, Chemistry - General, Organic, Biological
Loebel, Chemical Problems - Solving by Dimensional Analysis
Mahan, University Chemistry
Masterson
Masterson, et al., Mathematical Preparation for General Chemistry (2)
Masterson, Slowinski, Stanitski, Chemical Principles (9)
Malm & Frantz lab manual
Matta & Wilbraham, General, Organic, and Biological Chemistry
McQuarrie & Rock, Chemistry
McQuarrie & Rock, General Chemistry (4)
Melene, Basic Concepts of Chemistry
Mercier, Ault, Holtzclaw, Robinson, Problems and Solutions D. C. Heath
(has keystrokes to help students in the first use of a calculator beyond the four functions)
Miller & Augustine, Preparatory - Basic Chemistry
Moore, Physical Chemistry
Moore, Davies, Collins, Chemistry
Mortimer, General Chemistry
Mortimer, Chemistry - The Fundamental Science
C. E. Mortimer, Chemistry 6th ed. (6)
Mortimer & Dickerson
Oxtoby & Nachtrieb
Oxtoby & Nachtrieb, Principles of Modern Chemistry; Saunders (3)
Peters, Problem Solving for Chemistry; Saunders
Petrucci
Ralph Petrucci, General Chemistry; MacMillan (2)
Petrucci, General Chemistry
Petrucci, Chemistry
Quellette, Introduction to General, Organic and Biological Chemistry
Renquist, Cresswell, Head, Chemical Principles: A Programmed Text
Segal, Chemistry
Segal, Chemistry; Experiment and Theory (2)
Audiotape lessons by Shasiri; Saunders
Shoemaker, et al., Experiments in Physical Chemistry; McGraw-Hill
Siebring & Schaff, General Chemistry
Smith & Pierce
Sorum, How to Solve Chemistry Problems
Stoker, Introduction to Chemical Principles
Stryer and Zubay
Suse & Daub, Basic Chemistry; Prentice Hall

Whitten & Gailey, General Chemistry; Saunders (6)
F. L. Wiseman, Chemistry in the Modern World; McGraw-Hill
Zumdahl, Chemistry
Zumdahl (3)
Zumdahl, General Chemistry
Chemical Principles; Saunders
Cooper, Intro Pascal for Scientists
Day & Underwood, Quantitative Analysis
Dorn & McCracken, Numerical Methods with Fortran Case Studies
Merritt, et al., Instrumental Analysis
Willard, Merritt, Dean, Instrumental Methods of Analysis
Journal of Chemical Education
Audiovisual modules
CAI modules
TI Manual
Calculator manuals (2)
No text, but the following is included in a lecture:
Explanation of differences between arithmetic logic & scientific logic & Reverse Polish Notation, explanation of meaning of inverse on calculator vs. in mathematics

Biology

Courses for Non-majors
Math and General Topics

- Metric system
- Statistics (5)
- Chi^2 test (4)
- Probability
- Data analysis (2)
- Lab calculations (2)
- Scientific method
- Microscope

Biology Topics

- Population dynamics (4)
- Genetics (22)
- Population genetics (6)
- Evolution (4)
- Hardy-Weinberg law (3)
- Ecology (8)
- Oceans and man
- Basic chemistry (2)
- Enzyme kinetics
- Diffusion
- Osmosis
- Microbal growth (2)
- Cell dimensions
- Culture numbers
- Respiration (3)
- Photosynthesis (2)
- Energy & life
- Energetics
- Metabolism
- Human nutrition
- Human demography
- Growth curves
- Acid rain lab
- Soils lab

Courses for Biology Majors
Math and General Topics

- Area/volume relationships
- Binomial eq.
- Statistics (23)
- Chi^2 test (12)
- Probability (4)
- Data analysis (7)
- Lab calculations (3)
- Measurements
- Lab reports
- Scientific method

Biology Topics

- Population dynamics (9)
- Genetics (53)
- Population genetics (16)
- Evolution
- Hardy-Weinberg law (5)
- Competition
- Ecology (19)
- Growth curves (3)
- Limnology (2)
- Oceans and man
- Enzyme kinetics/rates (9)
- pH (5)
- Solutions/concentrations (4)
- Biochemistry/biochemical reactions (2)
- Diffusion (2)
- Stoichiometry
- Pigment analysis
- Acid/base chemistry
- Goldman equation
- Nernst equation
- Michadis/Menten equation
- Henderson/Haselbach equation
- Absorbance
- Osmosis
- Molecular biology
- Microbiology (2)
- Cell & virus dimensions
- Microbal growth
- Cell biology
- Cell membrane permeability
- Physiology (8)
- Photosynthesis (4)
- Respiration (3)
- Physiological Q_{10} (2)
- Energetics
- Immunology
- Converting %T to absorbance
- Electrical impulse calculation
- Rates of animal movement
- Calorimetry lab
- Life tables
- Organismic bio
- Geochemical cycles
- Water potential

Texts and Other Materials

Lab Manual/own handouts (10)
Ambrose & Ambrose, A Handbook of Biological Investigation
Becker, World of the Cell
Brower & Zar, Field & Laboratory Methods in Ecology
H. Curtis, Biology
Curtis & Barnes, Invitation to Biology
Emlen, Population Biology
Keeton & McFadden, Elements of Biological Science
Odum, Fundamentals of Ecology
Odum & Odum, Energy Basis for Man and Nature
Pai, Foundations of Genetics
Piarika, Evolutionary Ecology
Reid & Ward, Ecololgy of Inland Waters & Estuaries
Rickets, Ecology
Sanders, Biology - The Science of Life
William Schifler, Biostatistics
Sokal & Rohlf, Biometrics
R. L. Smith, Ecology & Field Biology
Starr & Taggart, Biology
Stephenson, Concepts in Cellular Chemistry
Stephenson, Concepts in Biochemistry
Vander, Human Physiology
Vander, Biology

Wetzel, Limnology
A. M. Winchester, Biology Laboratory Manual; Brown
Wolf, Biology: The Foundations
J. Zar, Biological Statistics
Explorations in Basic Biology
Minitab Instruction Guide
Diller & Goldstein, Multivariate Analysis

APPENDIX 2f. Comments Regarding Students' Calculator Use

Physics

General comments on intelligent use:

- Some do, some don't (Most instructors implied that the latter are a majority.) (9)
- Students quickly learn how to use them properly and efficiently. (2)
- The better students have obviously taught themselves more and are more proficient.
- Students focus too much on getting the right number instead of understanding the concepts.
- I don't think they use them as much in creative situations as just number crunching sequences.
- They are used effectively in problem solving and data analysis.

Overdependence/lack of math skills:

- Students are overdependent on calculators, and use them for estimations and simple calculations. (33)
- Some students use it as a substitute for thinking. (19)
- Students use them to avoid doing algebraic manipulations. (9)
- They use it for trig values they should know.
- I warn them that thinking stops when button-pushing begins.
- I try to discourage their use for approximations and simple calculations.
- I prefer estimating, and only using the calculator to obtain all significant digits.
- Their use attenuates student's ability to do "back-of-the-envelope" calculations.

Acceptance of calculator results:

- Students are not careful with significant figures. (23)
- Students don't check the calculator results with order of magnitude calculations. (12)
- Students accept results blindly, even when it should be obvious that they are incorrect. (10)
- The use it well, but can't interpret the results intelligently. (2)
- Significant figure problems have declined exponentially lately.
- The best students estimate before using the calculator.

Level of calculator skills:

- Most don't/can't use anything but the simple functions. (16)
- They don't use the memory, and don't trust themselves to do long algebraic substitution without writing down many intermediate steps. (5)
- They use every feature of it. (2)
- Some don't bother to read the manual.

Other comments:

- Much work could be done faster without them. (3)
- Time-saving - give more chance to develop reasoning and analytical skills through more practice. (3)
- Problems with sets of large numbers can be handled easily. (2)
- Calculators are necessary, for such things as logs, trig functions, and data analysis. (2)
- I include more work on my tests now than I did before the calculator.

*(n) represents the number of times the comment was mentioned, if that was more than once.

They make it possible for lower level students to solve higher level problems.
Students use them as an extension of their brains, not a substitute.
In lab, students are starting to use them to calculate slopes and for linear regression.
Use of the calculator gives a feeling for the quantities involved in a given area.
I help them individually, if needed.
It's just a tool - we expect them to learn to use it on their own. (2)
Be serious - who is going to use trig tables today, or calculate square roots.
The meaning of "intelligent use" is not clear.

Chemistry

General comments on intelligent use:
They use them reasonably well (or learn to quickly).(15)
Some do, some don't. (Most instructors imply that more don't.) (12)
They do after taking general chemistry, not before.
Those who don't drop out very quickly.
They become more proficient as the semester passes.

Overdependence/lack of math skills:
Students are overdependent on them for simple math. (36)
They can use calculators, but don't understand the theory behind what it's doing.(15)
Students' math skills atrophy. (4)
One student sums it up - she was using a calculator to keep track of electrons as she was writing an electron configuration.
Students do less algebra and more math using calculators.
In most cases the problem is not calculator use but lack of general problem-solving skills.

Acceptance of calculator results:
Too many significant figures (32)
Don't question results/recognize unreasonable answers. (25)
Don't check answer by estimating. (17)
They calculate without thinking. (7)
We emphasize estimating to check the calculated result.
I try to stress assessing reasonableness of answers.

Level of calculator skills:
Don't understand/make full use of capabilities (including memory). (23)
Few/none read the instruction manual. (6)
They do if they take the trouble to learn the calculator's capabilities.
They buy calculators which they don't know how to use.
Multi-step problems are difficult for students.

Other comments:
Saves time. (4)
They can do harder problems - less time spent on arithmetic.
This is not a math course - I want to teach chemistry!
Failure to use calculators is to live in the 19th century.
Side comment: This questionnaire seems so out-of-date and irrelevant! It would have been reasonable in 1975.

Biology

General comments on intelligent use:
- Some do, some don't. (4)
- Most students are proficient. (3)
- They use them well on large amounts of lab data. (2)

Overdependence/lack of math skills:
- Students are overdependent on calculators for simple math. (17)
- Lack of math skills and understanding of the functions in use (5)
- They use it without thinking about the problem. (4)
- If used correctly it avoids silly math errors some often make.

Acceptance of calculator results:
- They accept results blindly - have no feeling for reasonable answers. (7)

Level of calculator skills:
- Don't use full capabilities. (5)
- Those with type II know how to handle them better than me.

Other comments:
- Calculators are time-saving. (8)
- We care more that students know how to get an answer rather than how they do the calculations.
- Define intelligent!

APPENDIX 2g. Concerns Regarding Calculator Use on Standardized Tests

Physics

- Crib notes/memories
  - Cheating via programmable memories (37)
  - Do proctors know how to erase memories and do they have the time to check each one? (2)
  - How do you identify programmables?
- Equity:
  - The possible unfair advantage to those who have one or have a more advanced one (11)
  - Students may not be able to afford comparable types. (6)
  - Would a student's performance be seriously threatened if his/her calculator stopped functioning during the test? (2)
  - No concerns - almost everyone should be able to afford a type II.
  - It's one more factor in creating bias on these exams.
- Relation of calculators to skills tested:
  - Exams should test analytical skills and should be designed so calculators aren't really needed and thus provide no advantage. (26)
  - Allowing calculators may lead to misleading results regarding the measurement of students' knowledge and analytical skills. (7)
  - Students should know/demostrate knowledge of basic math. (5)
  - They are only tools and won't help students with the physics, so allow them. (6)
  - They should be allowed if certain problems are designed to be solved with intelligent calculator use, not just for trivial arithmetic. (3)
  - They're OK for simple number-crunching, and allow use of more realistic numbers. (3)
  - They shouldn't be allowed on math tests. (3)
  - Could no longer test estimating skills. (3)
  - It's OK to allow calculators if one goal is to test skill in using them, but this should be a small part of the total test.
- Student dependence/poor use:
  - Their use creates a lack of math and analytical skills in students, and thus students don't understand the basic concepts involved. (14)
  - Students are overdependent on them. (5)
  - Students don't think about physics - just push buttons to get an answer. (3)
  - Students lose track of significant figures.
  - Students fail to recognize obviously wrong answers.
- Other comments:
  - Calculators are a waste of time in most cases. (4)
  - Only say "yes" for physics tests because students feel uncomfortable without them.

Chemistry

- Crib notes/memories:
  - Programmable memories (65)
  - They shouldn't be allowed to share. (7)
  - Hiding papers (some instructors do not permit carrying cases) (3)

*(n) represents the number of times the comment was mentioned, if that was more than once.

Equity:
- All should have the same type. (8)
- Poor students may be disadvantaged. (4)
- Built-in conversions may provide an advantage. (4)
- All should have one.
- Those more skilled at calculator use may have an advantage.
- Students whose teachers forbid them will be at a disadvantage.
- Use should be well publicized since those who don't bring them will be disadvantaged.

Relation of calculators to skills tested:
- Concerns regarding use on math tests, especially the SAT (9)
- Keep math simple - focus on concepts. (8)
- The exams should be geared to calculator use. (2)
- Calculators should be allowed only after students have demonstrated math competence.
- Tests should measure basic math skills.
- Tests shouldn't measure calculator skill - give all answers in algebraic form.
- The lack of knowledge in the use of calculators may interfere with the application of the student's knowledge in the area.
- Probably will lower scores - problems posed will require more difficult calculations.
- Results of tests may not accurately indicate understanding.
- I think informative tests can be designed which either allow or prohibit calculators.
- A major overhaul of standardized tests is long overdue. A legitimate use of the calculator is to enable students to be better tested in the subject at hand (e.g., freed from stuff like division).

Student dependence/poor use:
- Atrophy of skills (4)
- They don't understand the meaning of logs or trig functions anymore. (3)
- I am not certain they understand the underlying logic.
- Students don't develop any number sense. (3)
- They calculate without thinking, err on significant figures, don't recognize unrealistic answers.

Other comments:
- They are normal equipment now (9) (just as slide rules were 15 years ago (3)).
- Save time (2) (which can be devoted to real chemistry).
- One can do more with calculators, but it doesn't add to understanding.
- We want them to learn to use calculators correctly in high school and use them on AP tests.
- Quite the contrary - it should be encouraged.
- Programming would take too much time.
- Many scientific calculators have arithmetic logic.

<u>Biology</u>

Crib notes/memories:
- Programmable memories (12)
- Programmables shouldn't be allowed. (3)
- Hiding notes in battery chambers
- Can store answers if passed around. (2)

Equity:
- Equal access to comparable calculators. (10) (They should be provided at test site.)
- Requires money to compete equally. (4)
- Equal access should be available throughout entire education.

Relations of calculators to skills tested:
- Tests should measure understanding and use simple numbers, not merely plugging into equations. (9)
- Need to test their math skills. (7)
- Use simple numbers/leave answers unsimplified (4)
- Need to test analytical thinking. (3)
- They need to know the math first - then they can be allowed calculators. (2)
- They should be able to perform routine computations and demonstrate this on tests. Calculators should be permitted when functions like logs are involved. (2)
- If math is being tested, shouldn't allow it. As a tool it's OK, i.e., you should use a calculator after you've learned to live without it.
- Less mental work would be tested.
- I believe we're attempting to measure the student's appreciation for numbers (i.e., appropriate answers) rather than their speed with the calculator.
- I don't see any value in making students do calculations on exams. Knowing how to set up problems is more important.
- They're OK if all you care about is a correct answer. If the route to the answer is important they probably shouldn't be used.

Student dependence/poor use:
- Atrophy of math skills/dependency (13)
- Students using calculators and not understanding theory (2)

Other comments:
- They are an important tool in science and used routinely in learning process. (3)
- Slide rule, calculator, what's the difference as long as the student's brain does the programming?
- If they can use calculators accurately/appropriately, these students probably have good insights into the mechanics and theory of the problems.
- If a student is merely a number puncher he won't get the right answers anyway. In this day and time intelligent use of a calculator is a necessary skill.
- Would permit more complex questions on tests.
- I would expect that the questions would be such that there would truly be need for calculators.
- On standard math tests, their use could mask some fundamental deficiencies.
- If use is required, are probably not testing the most imnportant concepts.
- Math and Biology NO. Chemistry and Physics YES.
- Possibly have separate test for calculator use.
- Think that by the time they get to college they ought to be able to decide when and when not to use a calculator.
- With the rapid increase in sophistication, it will be difficult to maintain a "standardized" test.
- I have more concerns about standardized tests themselves.

APPENDIX 2h. Responses for Part B: Microcomputers

Physics

8. For each introductory physics course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)	Non-calculus survey course sequence for non-physics majors	Calculus-based sequence for physics majors and/or engineers
Drill and practice	7/18	13/18
Use of tutorial software	7/31	17/30
Word Processing	10/21	16/28
Simulations of natural phenomena	11/26	23/47
Simulations of laboratory experiments	13/22	25/31
Analysis of laboratory data	24/45	44/79
Recording of laboratory data using interfacing device	13/27	25/47
Use of teacher-written programs. If so, what language?	8/18	14/26
Use of student-written programs. If so, what language?	2/4	6/8
Communication with information services or data bases.	5/2	5/2
Total number giving <u>any</u> response.	39/74	54/100
Percent giving <u>any</u> response.	50/55	60/71

(Programming languages listed on p. 115.)

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?	Yes	12/38	21/46
	No	25/42	30/50
If yes, about how many hours for the entire course sequence? (Numbers represent the average)		3.9/2.9	6.3/5.1
Number of schools reporting hours		10/24	15/29
10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?	Yes	4/24	13/33
	No	50/74	53/76

13. About what percent of hands-on laboratory experiments have been replaced by microcomputer simulations of laboratory experiments?

zero	58/88	59/92
1% - 25%	9/19	18/28
26% - 50%	1/1	0/2
51% - 75%	0/0	0/0
76% - 100%	0/0	1/0

Chemistry

8. For each introductory chemistry course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)	Course sequence for non-chemistry majors	Course sequence for chemistry majors
Drill and practice	19/51	27/68
Use of tutorial software	18/51	29/71
Word Processing	15/24	23/38
Simulations of natural phenomena	8/18	11/29
Simulations of laboratory experiments	9/25	15/34
Analysis of laboratory data	18/36	35/12
Recording of laboratory data using interfacing device	6/9	12/29
Use of teacher-written programs. If so, what language?	11/22	13/36
Use of student-written programs. If so, what language?	3/2	6/7
Communication with information services or data bases.	4/1	4/11
Total number giving any response.	20/51	36/91
Percent giving any response.	23/31	36/53

(Programming languages listed on p. 115.)

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?			
	Yes	19/28	24/54
	No	23/65	31/63
If yes, about how many hours for the entire course sequence? (Numbers represent the average)		1.5/8.7	2.5/9.5
Number of schools reporting hours		10/15	10/29

10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?			
	Yes	6/12	11/18
	No	49/101	55/116

13. About what percent of hands-on laboratory experiments have been replaced by micro-computer simulations of laboratory experiments?		
zero	70/131	80/139
1% - 25%	3/14	5/26
26% - 50%	0/0	0/0
51% - 75%	0/0	0/0
76% - 100%	0/0	0/0

Biology

8. For each introductory biology course sequence that you teach, check boxes to indicate in which areas microcomputers are used. (Check all that apply.)	Course sequence for non-biology majors	Course sequence for biology majors (or combined sequence
Drill and practice	8/15	14/25
Use of tutorial software	10/19	22/41
Word Processing	10/23	20/39
Simulations of natural phenomena	7/17	20/40
Simulations of laboratory experiments	4/18	21/36
Analysis of laboratory data	5/18	23/48
Recording of laboratory data using interfacing device	1/4	7/11
Use of teacher-written programs. If so, what language?	2/6	6/16
Use of student-written programs. If so, what language?	0/1	0/5
Communication with information services or data bases.	1/2	3/13
Total number giving any response.	20/42	44/81
Percent giving any response.	49/45	73/71

(Programming languages listed on p. 115.)

9. If microcomputers are used in your classes, is any time devoted to teaching or assisting students in the use of the microcomputer?			
	Yes	8/21	22/38
	No	14/31	21/41
If yes, about how many hours for the entire course sequence? (Numbers represent the average)		4/1.8	4/3.3
Number of schools reporting hours		5/11	14/23

10. Has the course been modified to include topics that are particularly suited to the use of the microcomputer?			
	Yes	5/17	16/22
	No	22/48	29/70

13. About what percent of hands-on laboratory experiments have been replaced by microcomputer simulations of laboratory experiments?		
zero	27/57	37/78
1% - 25%	1/14	14/25
26% - 50%	0/0	1/1
51% - 75%	0/0	0/0
76% - 100%	0/0	0/0

Programming Languages Used

		Courses for Non-Majors		Courses for Majors	
		Teacher	Student	Teacher	Student
Physics	Basic	43	17	63	38
	Pascal	8	1	8	7
	Assembler	4		5	
	Fortran	2		7	4
	Logo	1		1	
	Cobol			2	
	Forth			1	
	C			1	1
Chemistry	Basic	33	5	69	25
	Assembler			1	
	Fortran	3	1	8	4
	Pilot	1			
	C	1		2	
	Pascal	5	4	14	12
Biology	Basic	9	2	24	5
	Pascal	1		3	1
	DAL			1	
	Pilot			1	
	Fortran			2	1

14. Are there laboratory or other skills that you feel can be assessed using micro-computer simulations that cannot be assessed using paper and pencil tests?

Physics	Yes 21/31	No 36/52	No opinion 41/59
Chemistry	Yes 18/38	No 40/74	No opinion 34/71
Biology	Yes 24/20	No 15/51	No opinion 17/45

15. For each of the following tests, would you favor that micro-computer administered simulations designed to assess laboratory skills be given in conjunction with the normal test? (Numbers reported here are percents.)

Physics Achievement Test	Yes 8/12	No 58/44	No opinion 29/32
AP Physics B Examination	Yes 6/9	No 58/43	No opinion 30/35
AP Physics C Examination	Yes 6/9	No 58/43	No opinion 29/35
Chemistry Achievement Test	Yes 21/21	No 36/44	No opinion 29/29
AP Chemistry Examination	Yes 20/22	No 35/42	No opinion 28/28
Biology Achievement Test	Yes 13/17	No 44/41	No opinion 36/35
AP Biology B Examination	Yes 14/17	No 45/41	No opinion 33/35

16. Is a mainframe computer used in your course sequence?

		Course sequence for non-majors	Course sequence for majors
Physics	Yes	5/9	12/21
	No	71/108	68/110
Chemistry	Yes	10/11	16/28
	No	64/142	70/138
Biology	Yes	4/3	9/18
	No	31/81	45/99

17. About what percent of computer use in your course sequence involves the mainframe computer?

		Course sequence for non-majors	Course sequence for majors
Physics	zero	50/86	52/94
	1% - 25%	7/8	8/17
	26% - 50%	0/1	0/2
	51% - 75%	0/0	1/0
	76% - 100%	0/1	1/1
Chemistry	zero	51/128	56/123
	1% - 25%	9/6	12/14
	26% - 50%	0/1	2/4
	51% - 75%	0/1	0/1
	76% - 100%	2/3	2/7
Biology	zero	26/66	39/84
	1% - 25%	3/3	10/17
	26% - 50%	0/0	0/1
	51% - 75%	0/0	0/0
	76% - 100%	1/0	0/1

18. Are you interested in writing multiple-choice test questions for either the Achievement Test or AP Examinations?

Physics	Yes 16/34	No 92/122
Chemistry	Yes 27/52	No 79/142
Biology	Yes 10/24	No 51/101

19. Would you like to receive a copy of the questionnaire results?

Physics	Yes 78/126	No 30/32
Chemistry	Yes 87/152	No 22/41
Biology	Yes 24/109	No 37/16

APPENDIX 2i. Topics Involving Microcomputer Use

Physics

Non-calculus courses

Math and General Topics

- Data analysis (8)
- Graphing (3)
- Least Squares
- Data acquisition
- Numerical solutions (complex eqns.)
- Derivatives/integration
- Fourier series
- Simulations (3)
- Labs (3)
- Reports
- Drill
- Vectors

Physics Topics

- Mechanics (6)
- Kinematics (5)
- Free fall (2)
- Free fall with friction
- Projectiles (4)
- Distance & velocity measurement
- Dynamics (2)
- Collisions (4)
- Orbits (4)
- Gravitation
- Circular motion
- Simple harmonic oscillations (5)
- Wave motion (11)
- Electromagnetism (4)
- Electrostatics (3)
- Fields/field plotting (5)
- Circuits (4)
- Wheatstone bridge
- Induction
- Sound
- Optics (8)
- Thermal (2)
- Calorimetry
- Temperature/time graphs
- Temperature measurement
- Kinetic theory
- Radiation analysis
- Power plants/energy
- Modern (2)
- Nuclear counting
- Nuclear decay
- Stellar evolution

Calculus-based courses for Physics Majors

Math and General Topics

- Data analysis (18)
- Graphing data (12)
- Fitting data (9)
- Least squares
- Statistics (4)
- Data acquisition (2)
- Recording data (2)
- Solving differential eqn. (4)
- Integral approximations (3)
- Numerical solutions
- Derivatives/integration (2)
- Complex formula applications
- Fourier series
- Simulations (6)
- Labs (5)
- Interfacing in labs
- Reports (30)
- Drill
- Vectors (2)
- Oscilliscope lab
- As a timer

* (n) represents the number of times the topic was mentioned, if that was more than once. Related topics are grouped together, and listed in decreasing order of frequency.

Calculus-based courses for Physics Majors (continued)

Physics Topics

- Mechanics (11)
- Kinematics/accelerated motion (7)
- Projectiles (3)
- Free fall
- Free fall with friction
- Collisions (5)
- Dynamics (2)
- Circular motion
- Constant gravitiational field (2)
- Kepler orbits (4)
- Rotation (2)
- Non-linear mechanics (2)
- Scattering
- Simple harmonic oscillator (11)
- Wave motion (13)
- Sound
- Doppler effect
- Optics (13)
- Interference patterns
- Electricity and Magnetism
- Field plotting (2)
- Electric fields, potentials, and forces
- Circuits (2)
- AC circuits (2)
- Simultaneous circuit eqns. (2)
- Wheatstone bridge
- Induction
- Electromagnetism
- Thermal (2)
- Equilibrium
- Calorimetry
- Temperature measurement
- Temperature/time graphs
- Power plants/energy
- Gas laws
- Modern (3)
- Half-life/nuclear counting (2)

Chemistry

Courses for Non-Majors

Math and General Topics

- Metrics (3)
- Conversions (2)
- Data analysis (16)
- Graphing (3)
- Error analysis
- Statistics (2)
- Lab interfacing (3)
- Nomenclature (11)
- Drills (7)
- Simulations (6)
- Tutorials (3)
- Reports (3)
- Modelling
- Library research

Chemistry Topics

- Stoichiometry (13)
- Balancing equations (6)
- Chemical formulas (2)
- Gasses/gas laws (15)
- Equilibrium (21)
- Kinetics (23)
- Reaction rates (2)
- Rate law
- Electrochemistry (2)
- pH (3)
- Acids/bases
- Thermodynamics (7)
- Energy (2)
- Calorimetry
- Radioactivity/nuclear decay (5)
- Quantum mechanics
- Solutions (6)
- Titrations (8)
- Liquids
- Solids
- Spectra (3)
- Bonding
- Periodic table (2)
- Mass numbers
- Chemical Rxns.
- CAI (2)
- Molecular/atomic structure (8)
- Atomic orbitals (2)
- Electronic configurations
- Organic chemistry (3)

Courses for Chemistry Majors

Math and General Topics

- Metrics
- Conversions
- Data analysis (31)
- Statistics/statistical analysis (6)
- Graphing (6)
- Regression analysis (4)
- Least squares (4)
- Error analysis
- Data acquisition (7)
- Lab interfacing (4)
- Comparison of lab data
- Iterative solution
- Integration
- Nomenclature (7)
- Reports (4)
- Simulations (4)
- Drill (3)
- Modelling
- Library research

Chemistry Topics

- Stoichiometry (14)
- Balancing equations (7)
- Chemical formulas (2)
- Analytical unknowns
- Gases/gas laws (20)
- Kinetic theory (2)
- Diffusion
- Equilibrium (36)
- K_a
- K_{sp}
- Kinetics (46)
- Reactivity
- Electrochemistry (4)
- Electronic configurations
- Faraday's Law
- Redox (2)
- pH (5)
- Acids/bases (3)
- Colligative properties (2)
- Thermodynamics (11)
- Energy (2)
- Statistical mechanics
- Calorimetry
- Quantum (7)
- Radioactivity/nuclear decay (5)
- Solutions (7)
- Titration (13)
- Solids
- Density
- Liquids
- Spectroscopy/spectra (4)
- Bonding (3)
- M. O. description of bonding
- Periodic table (3)
- Mass numbers
- Gas chromatography
- Flow injection analysis
- CAI
- Atomic/molecular structure (13)
- Atomic orbitals (2)
- Atomic weights

Biology

Courses for Non-Majors

Math and General Topics

- Data analysis (4)
- Statistics (3)
- Chi^2 (2)
- Graphing
- Data collection
- Simulation (2)
- Papers/reports (2)
- Practice exams
- Drill exercises
- Tutorials
- Vocabulary
- Scientific method

APPENDIX 2i. (continued)

Courses for Non-Biology Majors (continued)

Biology Topics

- Population growth/dynamics (7)
- Genetics (25)
- Population genetics (2)
- DNA base pairing
- Evolution (6)
- Ecology (15)
- Pollution
- Water pollution
- Chemistry (2)
- Enzymes (2)
- Osmosis
- Osmoregulation
- pH
- Molecular bio/biomolecules (2)
- Cell biology/activities (2)
- Organelles
- Physiology (5)
- Photosynthesis (4)
- Respiration (4)
- Nerve physiology (2)
- Neuron function
- Muscle contraction
- Energetics
- Immunology
- Human nutrition
- Nutrition
- Circulation
- Anatomy
- Taxonomy
- Identification keys
- Light

Courses for Biology Majors

Math and General Topics

- Data analysis (8)
- Graphing (2)
- Statistics (9)
- Chi^2 (4)
- Papers/reports (6)
- Simulation (5)
- Vocabulary (2)
- Drill exercises
- Scientific method
- Animation of 3-D forms

Biology Topics

- Population growth/dynamics (11)
- Genetics (41)
- Population genetics (7)
- DNA/RNA (6)
- Protein synthesis (3)
- DNA replication
- Transcription
- Evolution (12)
- Hardy-Weinberg growth curves (2)
- Growth rate
- Competition
- Ecology (27)
- Enzymes (7)
- Osmosis (5)
- Diffusion (2)
- Kinetics
- Biochemistry
- Molecular bio/biomolecules (5)
- Cell biology/reproduction (4)
- Mitosis/meiosis (3)
- Cell chemistry (2)
- Organelles
- Microbiology
- Animation of molecular motion
- Analysis of human circadian rhythms
- Physiology (17)
- Photosynthesis (6)
- Respiration (4)
- Immunology (3)
- Biochemical pathways (2)
- Muscle contraction
- Transpiration
- Translation
- Neuron function
- Axonal conduction of action potentials
- Nutrition
- Gas carriage by hemoglobin
- Spirometry
- EKG
- Metablolism
- Biofeedback
- Circulation
- Human performance studies
- Taxonomy

APPENDIX 2j. Available Computer Models

		Physics		Chemistry		Biology	
Make	Model	Non-majors	Majors	Non-majors	Majors	Non-majors	Majors
Apple	unspecified	14	21	25	31	7	20
	MacIntosh	33	45	32	47	19	34
	MacIntosh +		1	1	3		
	II	18	26	23	31	8	16
	II+	15	15	7	11	2	6
	IIc	1	1		4	2	4
	IIe	47	40	42	61	18	42
	IIg	1	1				
	IIgs			2	3		
IBM	unspecified	8	14	20	25	12	21
	PC	56	61	45	67	22	42
	PC jr.			2	2		
	XT	9	13	10	15	2	3
	AT	1	8	4	11		2
	Mainframe/Unix			3	3	1	2
Commodore	unspecified	4	7	2	3	1	4
	64	9	18	4	5	2	3
	128		1			1	1
	PET	2	6	2	6		
	SuperPET			1	1		
	PET 64 K			1	1		
	PET 2001	1	1				
	9000 series		1				
	VIC 20	3	2		1		
Radio Shack	unspecified	6	7	5	4	3	6
(Tandy Corp.)	TRS 80 color					1	1
	TRS 80 I	1	1				
	TRS 80 II	1	1				
	TRS 80 III	1	1	1		1	
	TRS 80 IV	2	2	1	1	1	1
	Tandy 100	1					
	Tandy 1000			1	2		1
Franklin	unspecified	1	1				
	ACE		1				
DEC	unspecified			1	1	3	1
	PC 100						1
	Rainbow	6	7	8	14	4	9
	Professional	1	1				
	Pro-350	1		1	1		1
	VT-180			1	1		
	DecMate	1	1				
	DecScope			1	1		

APPENDIX 2j. (continued)

Hewlett-Packard	unspecified	1	3	1	2		
	80				1		
	81		1				
	86				2		
	85	1	3		1		1
	200	1	1				
	3000		1		1		
Atari	unspecified	1	1				1
	800 XL		1				
	1040		1				
Texas Instruments	unspecified			2	1		1
	Professional	1	1		1	1	1
	TI-59 (calc.)				1		
	99-4A			1	1		
NCR	unspecified		1				
	IV					1	1
AT&T	unspecified	1	2	8	7		3
	6300 series	5	6	4	5	1	2
	6400 series				1		
	7300 series				1	1	1
MS-DOS 16-bit (unspecified)		1	2				
Leading Edge PC		1	4	4	8	2	4
Epson Equity I PC		1	1		2		
Epson Equity II PC		1	1				
IBM Clones		5	11	6	6	2	7
IBM Compatibles		3	5	5	12	4	4
Kaypro PC		1	1				1
Compaq PC				1	5		
CP/M 8-bit machines							
Kaypro 2				1	1	2	1
Heath		1			1		
Northstar Horizon					2		
Epson QX-16					3		
Cromemco				1	1		
Televideo		1	1				
Zenith	unspecified	3	4	4	9	1	6
	100	2	3	1	1	1	1
	148					1	1
	150			1	3		
	152				1		
	158	2	3	4	4		1
	159	1	1				
	200		1				
	248			1	1		
	PC (MS-DOS)	1	2			1	1
	AT Compatible		1				
Victor	2000	1	1				
	9000	1	1				
Amiga		2	2				
MicroVax		1	1	1	1		
ARC						1	1
MTL				1			

APPENDIX 2j. (continued)

CDS			1	1		
NEC				1		
VAX	2	2	2	3	2	4
AIM 65	3	4				
Convergent Technologies	1	1				
Terak	1	1				
Laser 128	1	1				
Cordata PC 400		1				
Tektronix		1				
WANG			2	2		
Panasonic			1	1		
Digital DecScope				1		
Murrow			1	1		
PLATO terminals				2		
Sun Workstations						1
ITT Extra						1
Data General						1
Single Board Micros	1	1				
SYM	1	1				

APPENDIX 2k. Skills Assessed via Computers and Related Comments

Physics

Skills (and comments related to them)

Problem-solving skills via interaction and branching dependent on responses (12)
Ability to use a microcomputer (3)
Choosing instruments for experiment
Ability to read an instrument or scale
Programming skills
There is no substitute for real lab measurement (and its associated errors) - students need to learn lab skills. (20)
A computer only adds speed in collecting and analyzing large amounts of data. (15)
It may allow testing of slightly different skills, but probably not significant enough to warrant a change. (2)
They're good as a teaching tool, but not for testing. (2)
I think a microcomputer is to an experiment what a cartoon is to live drama.

Topics and other considerations

Thick lenses
Heat flow
Nuclear reactor kinetics
Mass spectroscopy
Special relativity
Astronomy
Chaos problems
Graphing (5)
Curve fitting
Fourier analysis
Monte Carlo simulations
Simulation
Imaginative use can be helpful, but adequate programs have not been developed.
In a first physics course, there are too many basic concepts to introduce. Increasing computer time would mean dropping some topics.

Chemistry

Skills (and concepts related to them)

Simulations require students to make decisions, design experiments, and interpret data to a greater extent. (6)
Skills whose paper testing would involve lengthy description that would be testing verbal skills as much as lab skills (2)
Concepts involving dynamic situations (2)
The ability to use a microcomputer (a vital tool for today's scientist) (2)
The ability to write, plan, and execute a complicated program is great training for technical people.
Rapidity of perception (e.g., ability to perceive two objects as being same or different when viewed from different perspectives)
Result analysis and directed reasoning
Analysis of data requiring numerical integration or least squares
Interactive responses
Manipulation of dials/knobs on an instrument
Manipulation of variables
There is no substitute for hands-on labs. (12)
No, but it could be a great deal quicker/easier on computers. (9)
Labs you don't have equipment for/equipment too expensive/equipment too dangerous (7)
Labs that are time consuming (3)
Branching dependent on student's answers (3)
Using a computer can be an obstacle to those not fully at home with it (but more can be expected from a student with a computer). (2)
I worry that the format and familiarity with it will bias the test results.
One has a chance to try many more things.
No, but computers can provide a changing scene.
Lab skills and paper & pencil skills are quite different. Simulations I've seen are a waste of time for introductory chemistry.
I enjoy the speed at which they can do things, but I want my students to understand the algorithm.
I feel interacting with a computer simulation is closer to an oral exam where the student must "think on his feet" rather than the atmosphere of a formal written exam.

Topics and other considerations

x-y transformation to linearize data
Bonding
Molecular models
Phase changes
Topics involving calculations that are too time-consuming otherwise
Visualization of molecular geometry would be easier
Perfect for 3-D representation of reactions
Interactive qualitative schemes for both organic & inorganic species are an excellent pre-lab assignment. Gas law simulations are also very clear.

Biology

Skills (and comments related to them)

Ability to collect and manipulate data
Measuring skills
Hypothesis generation and testing
Conclusions from variable manipulation
Stepwise sequences can be developed with self-testing and adjustment for errors built in.
Open-ended simulations with no pre-determined answers - ones that truly teach students to think
There's no substitute for actually doing the labs. (8)
Computers add speed but don't necessarily enhance skills. (4)
Not at this level - advanced courses could make many uses (3)
Don't think simulation will tell you much about lab skills, but maybe problem-solving skills could be tested.
Only time-consuming activities could be better assessed.
Yes, but I prefer to use a lab format because simulations remove "glitches" from scientific work and the exercise becomes "non-science".
A skillfully constructed simulation can recreate the exploratory nature of a good "real" lab experience. However, for assessment I'm not sure it's any better than a well-written paper examination.
I think they can be used, but for the sake of variety, time and cost we desire a combination.
Of course not, but it would be impractical to attempt things without a micro of some sort. The thing to remember is to think - that's what science is.
The interactive programming required for biology is not available or cannot be run on most micros presently available.
They may be readily developed, but not assessed.
Simulation can be used to guide students through difficult problems and as exit tests in lab.

Biology (continued)

Topics and other considerations

Statistical analysis of numerical data (8)
Analysis of nucleotide sequence data
Genetics (7)
Population studies/growth (4)
Ecology
Homeostatic systems
Evolution
Speciation/natural selection
Medical terminology
Physiological simulations
Meiosis/mitosis
Geological time
Electrophysiology
Modeling
Some models are too elegant to derive in limited lab time without micros.
Students must understand what the computer is doing (generally just solving tedious equations) before simulations lead to understanding. I think there is a danger of teaching computer skills instead of biology.
Simulations are useful in preparing for labs.
Many things not easily visualized on the board are easily understood using the computer.
Computer use facilitates analytical skills.
Not skills, but there are learning processes that can be assessed or enhanced.
Would be useful in modeling, but only as a teaching aid, not an assessing aid.
Simulations of labs are useful.